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BATHYPELAGIC CALANOID COPEPODS OF THE WESTERN INDIAN OCEAN[1]

By George D. Grice and Kuni Hulsemann[2]

The plankton and midwater trawl samples on which this paper is based were obtained during two cruises of R. V. *Anton Bruun* in 1963 and 1964, which, at that time, was participating in the Biological Program of the International Indian Ocean Expedition. The area in which the samples were collected extends from the northern Arabian Sea to approximately the latitude of the subtropical convergence in the southern Indian Ocean. The operation of the *Anton Bruun* in the Indian Ocean provided us with an opportunity to extend our studies on the systematics and the zoogeography of the bathypelagic calanoid copepods from the Atlantic to the Indian Ocean.

We would like to thank Misses Ann Mulcahy and Mary Ann Beecher for their help in sorting and counting the copepods of the plankton samples and Miss Cecilia Simons for inking the original figures. Mr. Bruce Rogers assisted in collecting the samples at sea.

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Methods and Materials

The area in the western Indian Ocean from where the 51 samples considered in this paper were obtained is bounded by latitude 18°N and 40°S and longitude 50°W and 80°W (fig. 1, table 1). Three types of collecting gear were used to sample the deep-living copepods:

Bé multiple plankton sampler: Six of the collections analyzed

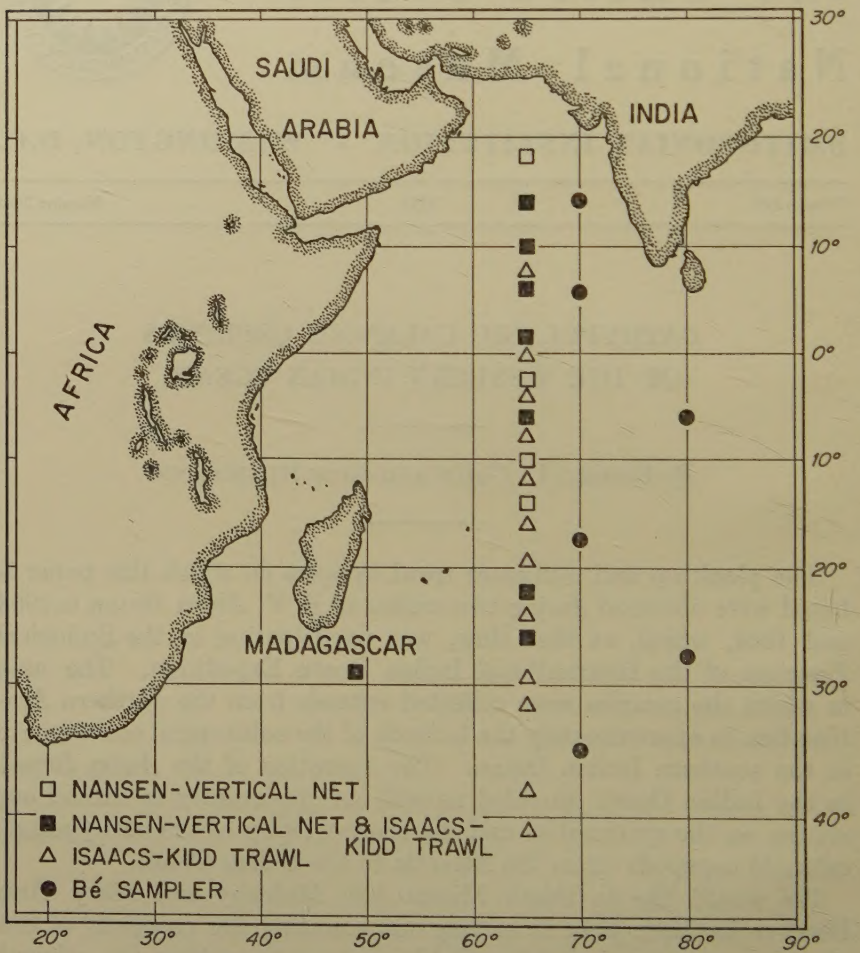

FIGURE 1.—Location of collection stations.

were collected by this sampler (described by Bé, 1962), hereafter designated the Bé net or sampler. The sampler was equipped with a number 3 net (.333 mm aperture), and the samples obtained between the 1000 and 2000 m depth interval on *Anton Bruun* Cruise 2 were studied. A total of 876 adult copepods (139 species) were identified in these samples. No volume measurements were made.

TABLE 1.—*Collection data* (blank space=volume not recorded, a=position at start of trawl, b=maximum depth from time-depth recorder (T) or wire angle (W))

Collection No.	Station No.	Date	Latitude	Longitude	Collection Depth (m)	Volume Plankton (cc)	No. Species Copepods
			Bé Sampler Collections (Cruise 2)				
1	108	25-V-63	13°50′N	70°07′E	2000-1000		40
2	112	29-V-63	05°48′N	70°03′E	2000-1000		50
3	123	10-VI-63	17°18′S	70°05′E	2000-1000		40
4	131	1-VII-63	35°09′S	69°59′E	2000-1000		41
5	134	6-VII-63	27°31′S	80°08′E	2000-1000		52
6	140	13-VII-63	05°53′S	79°57′E	2000-1000		53
			Isaacs-Kidd Midwater Trawl Collections (Cruise 6)				
7	330B	20-V-64	13°58′N [a]	65°02′E [a]	0-2750(T) [b]		3
8	332A	22-V-64	09°56′N	64°59′E	0-3250(W)		8
9	333A	23-V-64	07°55′N	64°55′E	350-2850(W)		21
10	333B	23-V-64	07°33′N	64°41′E	350- 940(W)		14
11	334B	24-V-64	05°48′N	64°57′E	275-2868(W)		17
12	336A	26-V-64	02°03′N	65°04′E	275- 817(W)		10
13	337B	28-V-64	00°14′S	65°03′E	275-2250(W)		26
14	339B	30-V-64	04°14′S	65°02′E	275-2080(W)		12
15	340A	31-V-64	05°55′S	65°10′E	275-2600(T)		21
16	341A	1-VI-64	08°00′S	65°00′E	0-3820(W)		8
17	343B	4-VI-64	12°11′S	64°11′E	225-1930(W)		17
18	345A	6-VI-64	15°57′S	64°46′E	0-2407(W)		7
19	346A	8-VI-64	19°24′S	65°30′E	225-2600(W)		18
20	347A	23-VI-64	22°11′S	64°53′E	350-2500(W)		21
21	348A	24-VI-64	24°03′S	65°00′E	350-3500(W)		17
22	349B	26-VI-64	26°24′S	65°02′E	350-1470(W)		26
23	351B	28-VI-64	29°45′S	64°58′E	350-1710(W)		25
24	351D	29-VI-64	31°45′S	65°08′E	350-1786(W)		16
25	353A	2-VII-64	37°59′S	64°56′E	350-2394(W)		22
26	354A	4-VII-64	40°48′S	65°03′E	0-1650(W)		18
27	355C	12-VII-64	29°29′S	48°43′E	0-3140(W)		22
			Nansen Vertical Net Collections (Cruise 6)				
28	328	17-V-64	18°02′N	65°08′E	2000- 750	1.5	37
29	328	17-V-64	18°02′N	65°08′E	3000-2000	1.0	18
30	330	20-V-64	13°36′N	65°03′E	1980-1050	1.0	40
31	332	22-V-64	10°04′N	64°59′E	2000-1002	0.7	40
32	332	22-V-64	10°04′N	64°59′E	3000-2000	0.5	19
33	332	22-V-64	10°04′N	64°59′E	4000-3000	0.5	8
34	334	24-V-64	06°01′N	64°59′E	2000-1078	0.7	9
35	334	24-V-64	06°01′N	64°59′E	3000-1894	0.5	16
36	336	27-V-64	01°30′N	65°09′E	2000-1000	1.0	41
37	336	27-V-64	01°30′N	65°09′E	3000-1940	0.7	21
38	338	29-V-64	02°38′S	65°01′E	2000-1000	1.0	41
39	338	29-V-64	02°38′S	65°01′E	3000-2000	0.3	26
40	340	31-V-64	06°00′S	65°10′E	1950-1015	1.0	41
41	340	31-V-64	06°00′S	65°10′E	2950-1990	0.5	28
42	342	2-VI-64	10°07′S	64°27′E	1970-1020	1.0	44
43	342	2-VI-64	10°07′S	64°27′E	3000-1980	0.7	32
44	344	5-VI-64	14°11′S	65°17′E	1980-1010	1.0	39
45	347	23-VI-64	22°06′S	64°55′E	2000-1000	0.3	33
46	349	25-VI-64	26°03′S	64°58′E	2000-1000	0.7	23
47	349	25-VI-64	26°03′S	64°58′E	3000-2000	0.5	8
48	349	25-VI-64	26°03′S	64°58′E	4000-3000	0.3	8
49	355	12-VII-64	29°38′S	49°23′E	2000-1000	0.5	11
50	355	12-VII-64	29°38′S	49°23′E	3000-2000	0.7	3
51	355	12-VII-64	29°38′S	49°23′E	4000-3000	0.7	8

Isaacs-Kidd midwater trawl: Twenty-one Isaacs-Kidd midwater samples (IK) collected on *Anton Bruun* Cruise 6 were examined and 10 to 70 copepods removed from each sample. The larger and deeper living species not usually collected in small vertical nets were selected from the trawl sample. The cod end of the trawl was made of number 2 mesh net (.366 mm). The maximum depth of trawling was determined from a time-depth recorder or calculated from measurements of length of wire-out vs. wire angle. Although a catch divider (Foxton, 1963) was attached to the end of the trawl, it apparently did not operate properly. Consequently, no attempt is made to discuss the vertical distribution of the species collected by the midwater trawl. A total of 797 adult copepods (113 species) were identified in these trawl samples.

Nansen vertical net: Twenty-four collections were also obtained on *Anton Bruun* Cruise 6 by a modified Nansen vertical net (NV). This net is similar to the one described by Currie and Foxton (1957) except that a flow-meter was mounted within the mouth of the net and a time-depth recorder (Benthos Mfg. Co., North Falmouth, Mass.) was attached to the weight below the cod end of the net. The net was made of number 6 mesh (.239 mm aperture). The samples from the following depth intervals are considered here: 2000–1000 m, 3000–2000 m, and 4000–3000 m. The time-depth recorder was equipped with a magnetic switch. Upon closure of the net, this switch activated a stylus that marked the recording chart. The maximum depth reached by the net and the depth of net closure was thus indicated on the chart. Since the speed of ascent of the net (60 m/min) and speed of descent of the messenger (200 m/min) that triggered the release and closure of the net was known, it was also possible to compute the depth of closing. In actual practice the depth of closing was clearly indicated in most cases by a severe jerk of the hydrographic wire when the throttling line pursed the net. When this occurred, the amount of wire out was recorded. Good agreement was found between the computed and actual depths of closure. The corrected depths are given in table 1. The method of measuring the volume of the NV samples and treating the copepods are the same as discussed in an earlier paper (Grice and Hulsemann, 1965). A total of 1740 adult copepods (194 species) were identified in these samples.

Contaminants: Twenty-six species of copepods collected by the NV net, which we feel may possibly have entered the net at shallower depths than those indicated, were found in many collections. These species, listed below, are in addition to those previously considered as contaminants in NV samples collected in the northeastern Atlantic Ocean (see Table II, Grice and Hulsemann,

1965). Species considered contaminants in samples collected with Nansen vertical net below 1000 m (in addition to those species listed by Grice and Hulsemann, 1965) are as follows:

Calanus tenuicornis
Canthocalanus pauper
Nannocalanus minor
Neocalanus gracilis
Undinula darwini
Acrocalanus longicornis
Acrocalanus monachus
Calocalanus pavo
Calocalanus plumulosus
Paracalanus denudatus?
Paracalanus nanus
Clausocalanus farrani
Euaetideus acutus
Scolecithricella maritima, new species
Scolecithricella species
Scolecithrix bradyi
Scolecithrix danae
Scolecithrix nicobarica
Temora discaudata
Undinella simplex
Lucicutia gaussae
Candacia catula
Paracandacia bispinosa
Paracandacia truncata
Labidocera detruncata
Acartia danae

In addition to the contaminant species recognized in the NV collections from the Indian Ocean, shallow-living species were also observed among the copepods in the six Bé net samples. To illustrate, 14 female *Metridia effusa* (a new species described below), a relatively large species (1.58–1.79 mm), were found in three Bé net samples that presumably sampled the 2000–1000 m depth interval; yet this species (18 females) also occured in five NV samples, all of which were collected in depth intervals between 1000 and 200 m. In none of the 12 NV collections obtained between 2000–1000 m was *M. effusa* observed. It was likewise absent from the 12 other NV collections obtained below 2000 m. These occurrence records for this species suggest that the depth data for species collected in the 2000–1000 m depth interval by the Bé net may not be reliable. For this reason we have included in the following discussion of vertical distribution only those species collected by the NV net as we are more familiar with the operation of this particular type of closing net.

Zooplankton and Copepod Abundance

The discussion in the following two sections is based on the analyses of the NV samples as only these collections were obtained quantitatively from several depth intervals in the water column and in the same manner as those collections previously analyzed by us from the northeastern Atlantic (Grice and Hulsemann, 1965).

Displacement volumes.—The displacement volumes of the samples collected by the NV net are shown in figure 2(A). The decrease in zooplankton concentration with increasing depth is clearly evident at all stations but one (station 355). In the depth intervals shown there appeared to be no region along the north-south transect of stations where there were significantly larger or smaller concentrations of zooplankton. On the contrary, omitting one station (station 347), there was no greater than a four-fold difference between the maximum and minimum concentration within the three depth intervals sampled. This is in contrast to our data (unpublished) on

the zooplankton in the upper 1000 m, where differences in volumes within the same depth intervals frequently are much larger.

The mean volumes for each of the three depth intervals can be compared to those we obtained in the northeastern Atlantic between 30° and 40°N (Grice and Hulsemann, 1965). For the depth intervals 2000–1000, 3000–2000, and 4000–3000 m the mean zooplankton volume for the Indian Ocean were .004, .002, and .002 cc/m^3, respectively and for the Atlantic Ocean, .005, .002, and .001 cc/m^3, respectively. These data are certainly similar and indicate how small

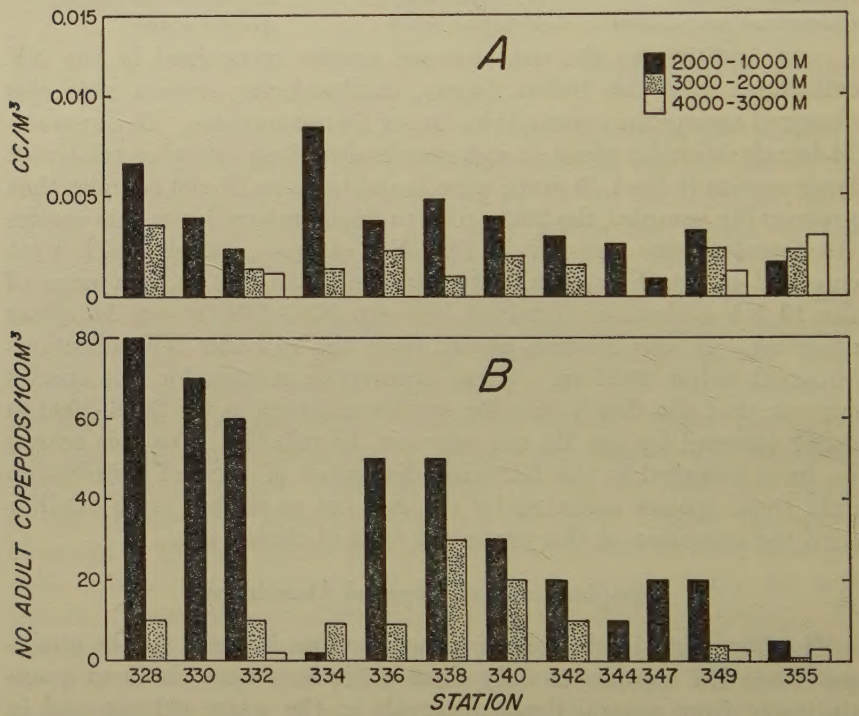

FIGURE 2.—Displacement volumes of the total zooplankton (A) and number of adult copepods excluding contaminant specimens (B).

the zooplankton population is at great depths in the northeastern Atlantic and western Indian Oceans.

COPEPOD ABUNDANCE.—The number of adult copepods per 100 cubic meter computed from the collections taken with the NV net are presented in figure 2(B). In general, the trends in copepod abundance are similar to those found for the total zooplankton. With but one exception the numbers of copepods within the 2000–1000 m interval were much larger than in the intervals below 2000 meters. In no case, however, did the numerical abundance exceed one copepod per

cubic meter and generally the densities were considerably smaller, especially below a depth of 2000 m. The single exception referred to above, where small numbers of copepods were found in the 2000–1000 m interval, was at station 334. Interestingly, the volume of zooplankton at this station exceeded that of all other stations. A large number of contaminant specimens (i.e., copepods that inhabit shallower depths) were noted in this sample. It thus appears that a considerable quantity of zooplankton from the upper 1000 m might have entered the net and was then retained during its descent to 2000 m; or, possibly, material from the 1000–500 m interval, collected just prior to the collection of the 2000–1000 m sample, may have remained attached to the meshes of the net due to incomplete washing of the net. These animals may have been washed into the plankton during the washing of the net after the 2000–1000 m collection. The volume of zooplankton and number of copepods obtained in the 3000–2000 m collection at station 334 does not appear to be unusual.

The number of adult copepods found in the depth intervals below 1000 m in the Indian Ocean are comparable to that previously found by us between 30° and 40°N in the northeastern Atlantic Ocean (Grice and Hulsemann, 1965).

Vertical Occurrence of Copepods

POPULATION MEAN SIZE.—We have measured the total length of 1277 adult copepods from the NV samples amd computed the mean size of the animals, excluding the "contaminant" species, collected within each depth interval. The 4000–3000 m interval will not be considered as only 19 adults were found in the three samples obtained from this interval.

The mean size of the adult copepods between 2000 and 1000 m was 2.36 mm and between 3000 and 2000 m, 2.19 mm. The range of mean sizes in these same intervals at four stations between 30° and 40°N in the northeastern Atlantic (Grice and Hulsemann, 1965) was 2.26–3.04 mm (2000–1000 m) and 1.71–2.38 mm (3000–2000 m). The size of the Indian Ocean copepods living between 1000 and 3000 m are quite comparable to those of the Atlantic.

SPECIES VERTICAL DISTRIBUTION.—Since the present study is based on the analyses of only those NV samples collected in depths below 1000 m, the shallow living species and families are poorly represented. There were present 153 species, excluding contaminants, in 13 families.

The predominantly shallow living families Eucalanidae and Pseudocalanidae were together represented by only seven species. No species, excepting those considered contaminants, of Calanidae, Paracalanidae, Centropagidae, Pontellidae, or Acartiidae, also epi-

pelagic families, were found in the NV samples collected below 1000 m.

The vertical range of many of the species in the 2000–1000 m interval extends into depths of less than 1000 m. Notably among these are species in the large families Aetideidae, Scolecithricidae, Lucicutiidae, and Augaptilidae. Each of these families is represented in our collections by 15 or more species.

Nine families of copepods had one-half or more of their species represented in depths below 2000 m. Only one family (Bathypontiidae) had more than one-half of its species (6 of 11) restricted to depths greater than 2000 m. The range of 9 of the 16 species in the family Spinocalanidae extended below 2000 m, but only 1 species was found exclusively below this depth. Species in these last two families are typical of collections made below 2000 m.

Concerning the 153 species, the largest number was found in the 2000–1000 m depth interval (122), an intermediate number in the 3000–2000 m interval (73), and the least number in the 4000–3000 m interval (13). A similar decrease in species diversity with increasing depth was noted by us (Grice and Hulsemann, 1965) in the northeastern Atlantic, where the decrease in diversity was as follows: 2000–1000 m (71), 3000–2000 m (59), and 4000–3000 m (28). In the Indian Ocean seven species were continually distributed from 1000 to 4000 m: *Mimocalanus cultrifer*, *Spinocalanus abyssalis*, *S. magnus*, *Metridia discreta*, *M. princeps*, *Lucicutia longiserrata*, and *Haloptilus longicornis*. Except for *L. longiserrata*, which we misidentified in our Atlantic samples (see Hulsemann, 1966), these species also occurred below 1000 m in the northeastern Atlantic. The first four we recorded in samples collected in excess of 4000 m.

Zoogeography

Geographic distribution of species.—Sewell (1948) has discussed the geographic distribution of copepods in some detail. His account represents an intensive analysis of the literature and attempts to relate the distribution of copepods to ocean currents. The discussion of the copepods in the Indian Ocean is based largely on his own numerous studies made there. A considerable section of his study is devoted to the deep-living copepods of the western Indian Ocean. We are mainly interested here in this discussion and that included in a recent paper by De Decker and Mombeck (1965) as these appear to be the only accounts concerning the zoogeography of the deep-living copepod species of the Indian Ocean.

Sewell (1948) recognized many North Atlantic Ocean species in the northern Indian Ocean. He indicated that these species may be carried southward from the North Atlantic by the North Atlantic

Intermediate water, then eastward into the southwestern Indian Ocean, and finally northward into the northern Indian Ocean by the Antarctic Intermediate water. Citing Sømme's (1933) view that the number of species in a current will decrease in the downstream direction, Sewell examined the occurrence of deep-water copepods at five stations in the Arabian Sea, the Gulf of Aden, and the Gulf of Oman. He indicated that the samples probably came from the Antarctic Intermediate water. He noted a gradual reduction of both deep-sea and North Atlantic copepods in a northward direction; i.e., the number of copepod species decreased from a maximum of 70 (including 56 North Atlantic species) to a minimum of 20 (12 North Atlantic species). The minimum number and the next to the minimum number of species were found in collections obtained in the Gulf of Aden and the Gulf of Oman, respectively. De Decker and Mombeck (1965) cited Sewell's Arabian Sea data and then applied Sewell's technique of examining the contribution of North Atlantic species to an even larger section of the Indian Ocean. These authors compared the number of Atlantic species (134) they found in the bathypelagic fauna of the southwest Indian Ocean with the number of Atlantic species found in the contents of six midwater trawl hauls (described by Sewell, 1929, 1932) made in the area between the Laccadive Sea and west of Andaman Island in the western part of the Bay of Bengal. De Decker and Mombeck pointed out that a gradual decrease of Atlantic species (20 to 0 species) occurred in a northerly and easterly direction.

Our transect of stations extending from approximately 18°N to 40°S along 65°E and 70°E, and one station at 29°S 49°E, in conjunction with the three different methods of collecting deep-water copepods has permitted us to sample a large number of deep-living calanoid species. We have specifically identified 269 species of calanoid copepods excluding the new species and those species found in two Bé net collections made in the eastern Indian Ocean (80°E). As we progressed in our taxonomic analyses of the samples, the similarity of the deep Indian Ocean copepod species to those of the Atlantic became clear. Of interest to us was the appearance of 13 of the 18 species we had recently described from the northeastern Atlantic (Hulsemann and Grice, 1963; Grice and Hulsemann, 1965).

Since our sampling program provided more systematic coverage of bathypelagic species than that of either Sewell (1929, 1932, 1947) or De Decker and Mombeck (1965), it is possible to look more closely into the occurrence of North Atlantic copepod species in the western Indian Ocean. For this analysis we have determined the number of copepod species in our samples in each of 10° latitude intervals

from 20°N to 40°S. A comparison of species found in the western Indian Ocean and the North Atlantic is as follows:

latitude interval western Indian Ocean	*number western Indian Ocean species*[3]	*number species common to North Atlantic*[4]	*percent of species in common*
20°N–10°N	98	90	92
10°N– 0°	117	100	85
0° –10°S	96	95	99
10°S–20°S	120	105	88
20°S–30°S	103	92	89
30°S–40°S	70	55	79

It is quite clear from examination of this tabulation that very large numbers of so-called North Atlantic species are present at all latitudes and that no significant decrease is evident in either the number of species within each interval (north of 30°S) or in the number within each interval that are also present in the North Atlantic Ocean. Thus, Sewell's view of the "falling off" of deep sea copepods and especially the reduction of North Atlantic species northwards in the Antarctic Intermediate water in the northern Arabian Sea is not supported by our data. Since the two stations where Sewell found the least number of copepods are in the Gulf of Oman and Gulf of Aden, the reduction of diversity at these stations may be related to conditions present in these relatively constricted areas.

Other studies on the hydrography of the western Indian Ocean may not entirely support Sewell's interpretation of water mass distribution. Sewell's report of Antarctic Intermediate water in the Arabian Sea is based on an investigation of Mohamed (1940) of pH distribution. Sewell also cited the work of Möller (1929), which indicated that northward flowing subpolar water (500–2000 m) is traceable only to about 5°N (Möller referred only to the eastern Indian Ocean). Sverdrup et al. (1942) indicated that Antarctic Intermediate water and Bottom water flows north and mixes with the deep water in the region north of the Equator. These water masses then flow to the south. According to Ivanenkov and Gubin (1960), in the area between 10° and 16°S the upper part of the southward flowing North Indian Deep water mixes with northward flowing sub-Antarctic Intermediate water and the lower part of the North Indian Deep water mixes with Antarctic Bottom water. This mixing results in the formation of two water masses: the South Indian Deep water (1500–3500 m), which flows southward and North Indian Bottom water (a layer of 200–700 m), which flows northward. Most of the NV and Bé net samples considered in this paper, which were

[3] Present in our samples.

[4] From Grice and Hulsemann (1965) and other literature records from North of 0°.

collected south of approximately 10°S, were probably obtained from within the South Indian Deep water. The midwater trawl (IK) also sampled this water during the greater part of each collection, The North Indian Deep water, formed in the northern Arabian Sea, is centered between 400 and 1500 m north of the Equator and between 800 and 2000 m south of the Equator. Most of our NV, Bé, and IK samples collected north of about 10°S were probably collected in this water mass.

It thus appears from Ivanenkov and Gubin's (1960) work that no sub-Antarctic water is present as such in the Arabian Sea. The continuity that apparently exists between the many species of copepods in the western Indian Ocean and the North Atlantic is apparently due to the transfer or movement of individuals from one water mass to another. Obviously this must be an extremely slow process, but as mentioned below, so might be the rate of speciation in these bathypelagic crustaceans.

Since De Decker and Mombeck's comments relate mostly to the occurrence of North Atlantic copepods (reported by Sewell, 1929, 1932, from six midwater trawl samples) mainly in the eastern Indian Ocean, where we have no samples, we are unable to compare their conclusions with our data. It may, however, be premature to conclude as De Decker and Mombeck did, that Atlantic Ocean copepods decrease in a northerly and easterly direction in the Indian Ocean. The midwater nets used by Sewell were made of "mosquito netting" and the number of copepod species collected in the six hauls was quoted by De Decker and Mombeck to be between only 1 and 54.

Rather than emphasize the decrease of Atlantic Ocean copepods, which our data fail to corroborate anyway, we wish to emphasize the extremely widespread distribution of bathypelagic copepods. The large number of our Indian Ocean species that are also common to the Atlantic (241 in all) is clear evidence for the effective dispersal of copepods by deep currents, slow and sluggish as these may be. Ninety-two percent of the deep-living species in the Arabian Sea, which is included in the northernmost interval (p. 10), are also found in the North Atlantic, some 8000 nautical miles distance. This high degree of similarity in copepod species may indicate a slow rate of speciation in these bathypelagic crustaceans, a suggestion that Day (1963) has already made for planktonic organisms.

Antarctic Species.—As indicated above, most of our collections contained species that are widely distributed in the deep waters. Certain of our collections obtained at the southern end of our sampling area, however, contained species we did not find elsewhere. Although few in number, these species have been included in a list of Antarctic and sub-Antarctic copepod species compiled by Vervoort (1965).

Three of the four collections in which we recognized Antarctic species were obtained from stations located between 35°S and 40°S, which is in the area of the subtropical convergence. The other collection where one Antarctic species occurred was obtained from 29°S.

The species in our collections that are especially indicative of Antarctic or sub-Antarctic waters and which have not been reported from elsewhere are *Calanus australis* Brodsky, *Euchaeta biloba* (Farran), and *Scolecithricella dentipes* Vervoort. *Rhincalanus gigas* Brady, a species much more important in the Antarctic because of its great abundance there, occurred in three of our collections made south of 35°S and in one collection made at 29°S. These four species were obtained in the Bé net and midwater trawl and were probably collected in the upper few hundred meters (see "Methods and Materials"). The occurrence of *R. gigas* at 29°S is considerably north of the subtropical convergence (approximately 40°S) and probably represents the northernmost distribution record for this species in the Indian Ocean. Thompson's (1900) report of *R. gigas* from 20°S has been questioned by Sewell (1929). *Metridia lucens* Boeck was also present in one sample (Bé net) from 35°S. It occurs in the North Atlantic and North Pacific Oceans and is also present in waters of high latitudes in the Southern Hemisphere. Thus, the above five species comprise the Antarctic element in our Indian Ocean copepod species.

Indian Ocean species.—There are few species in the Indian Ocean including the epi-planktonic ones that are not found elsewhere. Out of a total of 310 species found by us, 40 are not found in the Atlantic Ocean. Of these 40, however, only 7—*Bradycalanus gigas* Sewell, *Amallothrix indica* Sewell, *Scottocalanus dauglishi* Sewell, *Lucicutia bella* Hulsemann, *L. pallida* Hulsemann, *L. rara* Hulsemann, *Euaugaptilus indicus* (Sewell)—are apparently restricted to the Indian Ocean. The remaining ones are also present in Pacific or Antarctic waters. The above 7 species are in addition to the 17 species indicated by Sewell (1947, p. 540) as being possibly endemic to the Indian Ocean. Actually, due to subsequently published distribution records, 3 of these 17 species have been reported from the Pacific: *Chirundina indica* (Grice, 1962), *Cornucalanus indicus* (Brodsky, 1950; Tanaka, 1960), *Lucicutia aurita* (Tanaka, 1963, as *L. maxima*). Further, *L. aurita* has been found in the Malay Archipelago (Scott, 1909) and near the island of South Georgia (Gunther and Hardy, 1935), both times reported as *L. maxima* (see Hulsemann, 1966).

Our list of 310 species includes 78 that have not hitherto been reported from the Indian Ocean. This is not unexpected since the bathypelagic species have not been studied as extensively as the epipelagic ones. The discovery of 17 new species, which are described

in the present paper, is further indication of the paucity of prior taxonomic studies on the deep-water copepods of the Indian Ocean.

Taxonomy

One new genus, 17 new species, 8 previously unknown males, and 1 previously unknown female of calanoid copepods are described below. Systematic or distributional remarks are presented for 25 other species. Also included are descriptions and figures of 9 specimens which, because they may be referable to described species, are not recognized as new. Seven additional species of *Lucicutia* from these collections, which were not previously known from the Indian Ocean, are reported by Hulsemann (1966). In all, 310 species (300 were specifically identified) were found in the collections.

The forms of *Clausocalanus arcuicornis* (Dana) and *Microcalanus pygmaeus* (Sars) were not distinguished. The species designated *Euchaeta* species is being described elsewhere by Dr. Marion Fontaine.

In the description of the species the first to fifth thoracic segments refer to those to which the first to fifth pairs of feet are attached.

Holotype specimens have been deposited in the U.S. National Museum, Washington, D.C., and representative specimens of other species have been deposited in the Woods Hole Oceanographic Institution collections.

Species and collection numbers where they occurred are listed below. (The 78 species not previously known from the Indian Ocean are indicated by an asterisk. See table 1 for collecting data corresponding to collection number.)

CALANIDAE

*1. *Calanus australis* Brodsky, 1959 ---- 4
2. *C. tenuicornis* Dana, 1849 ---- 5, 43–45
3. *Canthocalanus pauper* (Giesbrecht, 1888) ---- 6, 41
4. *Nannocalanus minor* (Claus, 1863) ---- 6, 31, 34, 43–45
5. *Neocalanus gracilis* (Dana, 1849) ---- 3, 5, 43
6. *Undinula darwini* (Lubbock, 1860) ---- 6, 29, 30, 42, 43

MEGACALANIDAE

7. *Bathycalanus bradyi* (Wolfenden, 1905) ---- 7–11, 14, 15, 19, 20, 22–25
*8. *B. princeps* (Brady, 1883) ---- 24, 25
9. *B. richardi* Sars, 1905 ---- 10, 15
*10. *B. sverdrupi* Johnson, 1958 ---- 14, 19
11. *Bradycalanus gigas* Sewell, 1947 ---- 15, 27
*12. *B. sarsi* (Farran, 1939) ---- 9, 15, 18, 21
*13. *B. typicus* A. Scott, 1909 ---- 7, 8, 11
14. *Megacalanus princeps* Wolfenden, 1904 ---- 8–15, 17, 18, 20, 21

EUCALANIDAE

15. *Eucalanus attenuatus* (Dana, 1849) ---- 2, 16, 38, 45
16. *E. crassus* Giesbrecht, 1888 ---- 38
17. *E. elongatus hyalinus* (Claus, 1866) ---- 4–6, 19–24, 45

18. *Mecynocera clausii* Thompson, 1888 41–44
19. *Rhincalanus cornutus* (Dana, 1849) 2, 3, 6, 36
20. *R. gigas* Brady, 1883 4, 25–27
21. *R. nasutus* Giesbrecht, 1888 3–6, 27, 36, 44, 46

PARACALANIDAE

22. *Acrocalanus longicornis* Giesbrecht, 1888 44
23. *A. monachus* Giesbrecht, 1888 34, 42, 44
24. *Calocalanus contractus* Farran, 1926 48
25. *C. pavo* (Dana, 1849) 42, 43
26. *C. plumulosus* (Claus, 1863) 38
27. *C. styliremis* Giesbrecht, 1888 30–32, 34–43, 51
28. *Paracalanus aculeatus* Giesbrecht, 1888 28–30
29. *P. denudatus*? Sewell, 1929 30, 33, 34, 37, 42, 43
30. *P. nanus* Sars, 1907 37, 46, 51

PSEUDOCALANIDAE

31. *Clausocalanus arcuicornis* (Dana, 1849) 4–6, 30, 39–46, 48, 49
32. *C. farrani* Sewell, 1929 38, 40–44
33. *C. furcatus* (Brady, 1883) 6, 28–31, 34, 38–41, 44, 45
34. *C. paululus* Farran, 1926 46–48, 51
35. *Ctenocalanus vanus* Giesbrecht, 1888 40, 42, 43, 45, 51
36. *Farrania frigida* (Wolfenden, 1911) 3, 39, 41
37. *Microcalanus pygmaeus* (Sars, 1900) 28, 30, 31, 36–40

SPINOCALANIDAE

38. *Mimocalanus cultrifer* Farran, 1908 1, 2, 4–6, 28–32, 35–48
39. *M. inflatus*? Davis, 1949 36, 45
*40. *M. nudus* Farran, 1908 6, 31, 46
41. *Mimocalanus* species 39
42. *Monacilla tenera* Sars, 1907 30, 31, 40, 42, 45, 49
43. *M. typica* Sars, 1905 2-6, 34, 36, 38
*44. *Spinocalanus abruptus* Grice and Hulsemann, 1965 29, 31, 42, 45
45. *S. abyssalis* Giesbrecht, 1888 1-3, 5, 28, 30, 31, 35-39, 42, 43, 45, 46, 49
S. abyssalis var. *pygmaeus* Farran, 1926 1, 2, 4-6, 28-49
*46. *S. angusticeps* Sars, 1920 4, 6, 36, 40, 45
*47. *S. longipes* Tanaka, 1956 1, 28
48. *S. magnus* Wolfenden, 1904 1-6, 29, 33, 35, 37, 39, 43, 44
*49. *S. ovalis* Grice and Hulsemann, 1965 35, 51
50. *S. spinosus* Farran, 1908 1-3, 5, 6, 28, 30, 31, 36, 39, 40, 42-46, 50
*51. *S. validus* Sars, 1905 23, 45
52. *S. ventriosus*, new species 31, 32, 38, 41, 46
53. *Spinocalanus* species 46
*54. *Teneriforma naso*, new combination 28, 37, 38

AETIDEIDAE

55. *Aetideopsis retusa*, new species 43
56. *Aetideus armatus* (Boeck, 1872) 5
*57. *Batheuchaeta lamellata* Brodsky, 1950 51
58. *Bradyetes florens*, new species 38
59. *Bradyidius bradyi* (Sars, 1902) 35
60. *Chiridiella macrodactyla* Sars, 1907 28, 38
61. *Chiridius poppei* Giesbrecht, 1892 2, 5
62. *Chirundina indica* Sewell, 1929 3, 13
63. *C. streetsi* Giesbrecht, 1895 5, 6, 16, 19-23, 27
*64. *Chirundinella cara* Tanaka, 1957 12

65. *Euaetideus acutus* (Farran, 1929) 44
66. *Euchirella amoena* Giesbrecht, 1888 13, 16
67. *E. bella* Giesbrecht, 1888 1, 2, 11, 21, 28, 30
68. *E. bitumida* With, 1915 22, 27
69. *E. curticauda* Giesbrecht, 1888 40
70. *E. formosa* Vervoort, 1949 20, 22, 23
71. *E. galeata* Giesbrecht, 1888 12, 13
72. *E. maxima* Wolfenden, 1905 1, 13, 16
73. *E. messinensis* (Claus, 1863) 19, 22, 27
74. *E. pulchra* (Lubbock, 1856) 2, 36, 40, 42, 44
75. *E. venusta* Giesbrecht, 1888 38
76. *Gaetanus antarcticus* Wolfenden, 1905 9, 13-15, 21-26
77. *G. armiger* Giesbrecht, 1888 2
*78. *G. brachyurus* Sars, 1907 4, 19, 21
79. *G. curvirostris* Sars, 1905 42
*80. *G. ferox* With, 1915 5
81. *G. kruppii* Giesbrecht, 1903 11, 21, 28
82. *G. latifrons* Sars, 1905 23
83. *G. minor* Farran, 1905 5
84. *G. pileatus* Farran, 1903 4, 32
*85. *Gaidius brevicaudatus* (Sars, 1907) 37
86. *G. minutus* Sars, 1907 36, 40
*87. *G. robustus* (Sars, 1905) 17, 22, 25
88. *G. tenuispinus* (Sars, 1900) 36
89. *Pseudeuchaeta brevicauda* Sars, 1905 4, 11, 13, 14, 17, 19, 22, 37
*90. *Pseudochirella divaricata* (Sars, 1905) 19
*91. *P. dubia* (Sars, 1905) 9, 50
*92. *P. gibbera* Vervoort, 1949 11, 13, 15, 24
93. *P. hirsuta* (Wolfenden, 1905) 24–26
94. *P. magna* (Wolfenden, 1911) 26
95. *P. obtusa* (Sars, 1905) 1, 13, 26
*96. *P. polyspina* Brodsky, 1950 25
*97. *P. pustulifera* (Sars, 1905) 22?, 24, 25
*98. *P. semispina* Vervoort, 1949 13
99. *P. squalida*, new species 23
*100. *P. tuberculata* Tanaka, 1957 16
101. *Undeuchaeta intermedia* A. Scott, 1909 6, 38
102. *U. major* Giesbrecht, 1888 17
103. *U. plumosa* (Lubbock, 1856) 2–4, 23, 44, 46
104. *Valdiviella brevicornis* Sars, 1905 11, 13, 15, 20, 36, 41
105. *V. insignis* Farran, 1908 7–17, 19, 21–27, 37, 38
106. *V. oligarthra* Steuer, 1904 15

EUCHAETIDAE

107. *Euchaeta barbata* Brady, 1883 22, 24, 25
108. *E. biloba* (Farran, 1929) 4
109. *E. bisinuata* Sars, 1907 6, 20, 22, 36
*110. *E. calva* (Tanaka, 1958) 9, 10, 12, 13, 26
111. *E. dubia* Esterly, 1906 24–26
112. *E. exigua* Wolfenden, 1911 4
*113. *E. farrani* With, 1915 26
114. *E. gracilis* Sars, 1905 24, 27
115. *E. hanseni* With, 1915 11–13

116. *E. malayensis* (Sewell, 1929)---- 3, 26, 27
117. *E. marina* (Prestandrea, 1833)---- 29, 30, 39
*118. *E. robusta* Wolfenden, 1911---- 2
119. *E. sarsi* Farran, 1908---- 12, 17, 25
120. *E. scotti* Farran, 1908---- 8, 9, 20
121. *E. tonsa* Giesbrecht, 1895---- 22, 26, 40
122. *E. weberi* (A. Scott, 1909)---- 12, 13
123. *E. wolfendeni* A. Scott, 1909---- 44
124. *Euchaeta* species---- 24–26
PHAENNIDAE
125. *Cornucalanus chelifer* (Thompson, 1903)---- 25
126. *C. indicus* Sewell, 1929---- 23
127. *C. simplex* Wolfenden, 1905---- 15
*128. *Heteramalla dubia* (T. Scott, 1894)---- 40
129. *Onchocalanus affinis* With, 1915---- 1
130. *O. magnus* (Wolfenden, 1906)---- 17, 23, 24
131. *O. trigoniceps* Sars, 1905---- 1
132. *Xanthocalanus greeni* Farran, 1905---- 10, 14
133. *X. hispidus*, new species---- 49
*134. *X. obtusus* Farran, 1905---- 47
SCOLECITHRICIDAE
135. *Amallothrix arcuata* (Sars, 1920)---- 3
*136. *A. curticauda* (A. Scott, 1909)---- 5
137. *A. emarginata* (Farran, 1905)---- 2, 22, 23, 28, 43, 45, 46
138. *A. gracilis* (Sars, 1905)---- 1, 3
139. *A. indica* Sewell, 1929---- 1, 4, 28, 30, 31, 38, 40, 41
*140. *A. mollis* (Esterly, 1913)---- 2
*141. *A. obtusifrons* Sars, 1905---- 27, 32
142. *A. paravalida* Brodsky, 1950---- 3–6, 31, 38, 49
*143. *A. robustipes* Grice and Hulsemann, 1965---- 6, 40
144. *A. valida* (Farran, 1908)---- 2, 9, 11, 29, 38
145. *Lophothrix frontalis* Giesbrecht, 1895---- 20, 22, 23, 27, 49
146. *L. humilifrons* Sars, 1905---- 11, 13, 23, 27
*147. *L. insignis* Sars, 1920---- 15
*148. *Racovitzanus levis* Tanaka, 1961---- 5
*149. *R. porrectus* (Giesbrecht, 1888)---- 2, 28, 40
150. ?*Racovitzanus* species---- 29
151. *Scaphocalanus affinis* (Sars, 1905)---- 6, 19, 30, 44
*152. *S. bogorovi* Brodsky, 1955---- 43, 45
153. *S. brevicornis* (Sars, 1900)---- 1, 4, 6, 28, 30, 31, 45
*154. *S. curtus* (Farran, 1926)---- 5, 6, 36, 38
*155. *S. echinatus* (Farran, 1905)---- 3
156. *S. elongatus* A. Scott, 1909---- 1–3, 5, 29, 36, 38–40, 42, 44, 45
*157. *S. longifurca* (Giesbrecht, 1888)---- 1, 5, 36, 39, 41, 45
158. *S. magnus* (T. Scott, 1894)---- 3, 29, 36, 37, 39, 40
159. *S. major* (T. Scott, 1894)---- 3, 5, 41
160. *S. subbrevicornis* (Wolfenden, 1911)---- 1–6, 28, 30, 31, 36, 38, 40, 42, 43, 45
*161. *Scolecithricella auropecten* (Giesbrecht, 1892)---- 2, 31
162. *S. dentata* (Giesbrecht, 1892)---- 2, 5, 6
163. *S. dentipes* Vervoort, 1951---- 4
164. *S. grata*, new species---- 4
*165. *S. laminata* (Farran, 1926)---- 36, 40, 42

166. *S. maritima*, new species 31, 40
167. *S. ovata* (Farran, 1905) 36
*168. *S. profunda* (Giesbrecht, 1892) 2
*169. *S. spinata* Tanaka, 1962 ..... 2, 6
*170. *S. timida* Tanaka, 1962 ..... 2, 3, 38, 40
*171. *S. unispinosa* Grice and Hulsemann, 1965 47
172. *Scolecithricella* species 36
173. *Scolecithrix bradyi* Giesbrecht, 1888 ..... 42, 43
174. *S. danae* (Lubbock, 1856) 34, 42, 43
*175. *S. fowleri* Farran, 1926 42
176. *S. nicobarica* Sewell,1929 ..... 28, 30
177. *Scottocalanus dauglishi* Sewell, 1929 9
178. *S. helenae* (Lubbock, 1856) 26
THARYBIDAE
*179. *Undinella brevipes* Farran, 1908) 31, 42
TEMORIDAE
180. *Temora discaudata* Giesbrecht, 1889 41
181. *Temoropia mayumbaensis* T. Scott, 1894 ..... 28, 29, 31, 32, 35–39, 41, 44–47
METRIDIIDAE
182. *Gaussia princeps* (T. Scott, 1894) 8–11, 14, 19, 25
183. *Metridia boecki* Giesbrecht, 1889 ..... 2, 4, 28, 37, 38, 44, 46
184. *M. brevicauda* Giesbrecht, 1889 ..... 1–6, 28, 30, 31, 35, 36, 40, 42, 49
*185. *M. discreta* Farran, 1946 ..... 1, 4, 29–33, 35, 39, 41, 43, 46, 48, 49
186. *M. effusa*, new species 1, 5, 6
187. *M. lucens* Boeck, 1864 4
188. *M. macrura* Sars, 1905 ..... 1, 3, 15, 21, 31, 32, 37, 41
189. *M. princeps* Giesbrecht, 1889 ..... 2, 6, 8, 10, 12, 13, 15, 17–28, 31, 35–37, 40 42, 46, 51
190. *M. venusta* Giesbrecht, 1889 2–6
191. *Pleuromamma abdominalis* (Lubbock, 1856) 2, 3, 5, 38
192. *P. gracilis gracilis* (Claus, 1863) 2, 4–6, 44
193. *P. indica* Wolfenden, 1905 ..... 1, 2, 5, 30, 31, 42
194. *P. piseki* Farran, 1929 31
195. *P. quadrungulata quadrungulata* (Dahl, 1893) 2, 6, 36, 40
196. *P. xiphias* (Giesbrecht, 1889) 2–6, 11, 13, 16, 18, 27, 38, 40
CENTROPAGIDAE
197. *Centropages gracilis* (Dana, 1849) 6
LUCICUTIIDAE
198. *Lucicutia aurita* Cleve, 1904 ..... 9, 13–17, 40, 44
199. *L. bella* Hulsemann, 1966 ..... 20, 21, 27, 46
200. *L. bicornuta* Wolfenden, 1905 ..... 17, 22, 27
201. *L. curta* Farran, 1905 ..... 2, 4–6, 30, 31, 36, 40, 43, 46
202. *L. flavicornis* (Claus, 1863) 3–5, 42, 45, 47
203. *L. formosa* Hulsemann, 1966 ..... 27, 51
204. *L. gaussae* Grice, 1963 ..... 3, 42, 43
205. *L. grandis* (Giesbrecht, 1895) 1, 2, 5, 21, 22, 25–28, 30, 31, 40
206. *L. intermedia* Sars, 1905 ..... 1, 30, 40–42, 44, 45
207. *L. longicornis* (Giesbrecht, 1889) 1, 2, 28, 30, 31
208. *L. longiserrata* (Giesbrecht, 1889) 3–6, 30, 31, 42, 44
209. *L. longispina* Tanaka, 1963 ..... 33, 38, 39
210. *L. lucida* Farran, 1908 6
211. *L. magna* (Wolfenden, 1903) 5

*212. *L. major* Wolfenden, 1911 ---- 39
213. *L. maxima* Steuer, 1904 ---- 11, 13, 15, 20, 27
214. *L. ovalis* (Giesbrecht, 1889) ---- 1–6, 30, 31, 36–38, 40–42, 44, 45, 49, 50
215. *L. pallida* Hulsemann, 1966 ---- 3, 18, 23
216. *L. parva* Grice and Hulsemann, 1965 ---- 5, 28–32, 35, 36, 38, 39, 41–47
217. *L. polaris* Brodsky, 1950 ---- 38
218. *L. rara* Hulsemann, 1966 ---- 22, 25, 27
219. *L. sewelli* Tanaka, 1963 ---- 32, 41
220. *L. wolfendeni* Sewell, 1932 ---- 4, 9, 13–15, 22, 25, 26, 42
HETERORHABDIDAE
*221. *Disseta minuta* Grice and Hulsemann, 1965 ---- 28, 30–32, 35, 36, 45, 46
222. *D. palumboi* Giesbrecht, 1889 ---- 1, 2, 5, 6, 9–11, 13–15, 17, 18, 20, 22, 23, 30 36, 44
223. *Hemirhabdus grimaldii* (Richard, 1893) ---- 8, 9, 23, 24
*224. *H. latus* Sars (1905) ---- 17, 19, 44
225. *Heterorhabdus abyssalis* (Giesbrecht, 1889) ---- 2, 5, 6, 28–30, 32, 35–37, 40–42, 45
226. *H. clausi* (Giesbrecht, 1889) ---- 38, 40
227. *H. compactus* (Sars, 1900) ---- 1, 2, 4, 6, 30, 31, 38, 41, 43, 46, 49
228. *H. norvegicus* (Boeck, 1872) ---- 2–4, 6, 36, 38
229. *H. papilliger* (Claus, 1863) ---- 2, 6, 43, 44
*230. *H. robustus* Farran, 1908 ---- 6
231. *H. spinifrons* (Claus, 1863) ---- 3, 4
232. *Heterostylites longicornis* (Giesbrecht, 1892) ---- 1, 28
233. *H. major* (Dahl, 1894) ---- 31
*234. *Mesorhabdus brevicaudatus* (Wolfenden, 1905) ---- 3
AUGAPTILIDAE
235. *Augaptilus glacialis* Sars, 1900 ---- 2, 5
*236. *Centraugaptilus cucullatus* Sars, 1905 ---- 19
237. *C. horridus* (Farran, 1908) ---- 17, 21–23
*238. *Disco inflatus* Grice and Hulsemann, 1965 ---- 3, 28, 30, 32, 36, 37, 39–42, 44, 45
*239. *D. longus* Grice and Hulsemann, 1965 ---- 33, 36
*240. *D. minutus* Grice and Hulsemann, 1965 ---- 28, 32
241. *Disco* species ---- 41
*242. *Euaugaptilus brodskyi* Hulsemann, 1967 ---- 23, 36
243. *E. bullifer* (Giesbrecht, 1889) ---- 30, 31, 38, 42
244. *E. curtus*, new species ---- 1
245. *E. elongatus* (Sars, 1905) ---- 32, 44
246. *E. facilis* (Farran, 1908) ---- 30
*247. *E. farrani* Sars, 1920 ---- 40
248. *E. filigerus* (Claus, 1863) ---- 1, 9
249. *E. fundatus*, new species ---- 1
*250. *E. gracilis* (Sars, 1905) ---- 32, 39
251. *E. grandicornis* Sars, 1920 ---- 1, 2, 9, 30
*252. *E. humilis* Farran, 1926 ---- 5, 28, 36
253. *E. indicus* Sewell, 1932 ---- 14, 15, 30
254. *E. laticeps* (Sars, 1905) ---- 3, 9, 13, 19–22, 46
255. *E. longimanus* (Sars, 1905) ---- 1, 3, 15, 20, 28, 42
*256. *E. longiseta* Grice and Hulsemann, 1965 ---- 28, 39
257. *E. magnus* (Wolfenden, 1904) ---- 1, 9–13, 15 17, 19, 21–25, 27, 30, 31, 35, 44, 49
258. *E. malacus*, new species ---- 5
*259. *E. maxillaris* Sars, 1920 ---- 5

260. *E. nodifrons* (Sars, 1905)---- 1, 4, 5, 9, 17, 21, 23, 26, 28, 37, 38
261. *E. oblongus* (Sars, 1905)---- 1, 2, 10, 13, 29
262. *E. palumboi* (Giesbrecht, 1889)---- 1, 3, 5, 6
263. *E. penicillatus* Sars, 1920---- 3
264. *E. quaesitus*, new species---- 32
265. *E. rectus*, new species---- 13
*266. *E. rigidus* (Sars, 1907)---- 5, 38
267. *E. tenuispinus* Sars, 1920---- 28
268. *Euaugaptilus* species 1---- 28
269. *Euaugaptilus* species 2---- 6
270. *Euaugaptilus* species 3---- 20
271. *Haloptilus acutifrons* (Giesbrecht, 1892)---- 31, 42
272. *H. chierchiae* (Giesbrecht, 1889)---- 1, 2, 28
273. *H. longicornis* (Claus, 1863)---- 1–6, 30, 31, 36, 38, 40, 42–45, 48
274. *H. tenuis* Farran, 1908---- 40
275. *H. validus* Sars, 1920---- 10
*276. *Pachyptilus abbreviatus* (Sars, 1905)---- 9
277. *P. eurygnathus* Sars, 1920---- 20, 22, 23, 27
278. *P. pacificus* Johnson, 1936---- 15, 25
*279. *Pontoptilus mucronatus* Sars, 1905---- 9, 10, 20
*280. *P. robustus* Sars, 1905---- 10
281. *P. lacertosus*, new species---- 20
*282. *Pseudaugaptilus longiremis* Sars, 1907---- 42

ARIETELLIDAE

283. *Arietellus simplex* Sars, 1905---- 17, 18, 20, 25, 26, 42
284. *Phyllopus aequalis* Sars, 1920---- 1
285. *P. bidentatus* Brady, 1883---- 19, 29
286. *P. helgae* Farran, 1908---- 5, 23
287. *P. impar* Farran, 1908---- 6, 28, 31
288. *P. muticus* Sars, 1907---- 45

CANDACIIDAE

289. *Candacia catula* (Giesbrecht, 1889)---- 43
*290. *C. elongata* (Boeck, 1873)---- 4
291. *C. ethiopica* (Dana, 1849)---- 6
292. *C. longimana* (Claus, 1863)---- 5
293. *Paracandacia bispinosa* (Claus, 1863)---- 43, 44
294. *P. truncata* (Dana, 1849)---- 6, 44

PONTELLIDAE

295. *Labidocera detruncata* (Dana, 1849)---- 44

BATHYPONTIIDAE

*296. *Bathypontia elongata* Sars, 1905---- 2, 6, 17, 28
297. *B. major* (Wolfenden, 1906)---- 20
298. *B. regalis*, new species---- 39
*299. *B. sarsi* Grice and Hulsemann, 1965---- 37
*300. *B. similis* Tanaka, 1965---- 39
301. *B. spinifera* A. Scott, 1909---- 2, 3, 5, 6, 36, 42, 44, 46
*302. *Foxtonia barbatula* Hulsemann and Grice, 1963---- 35, 39, 43
303. *Rhinomaxillaris bathybia*, new genus and new species---- 30
*304. *Temorites brevis* Sars, 1900---- 2, 4, 6, 42
*305. *T. discoveryae* Grice and Hulsemann, 1965---- 32, 33, 35
*306. *Zenkevitchiella atlantica* Grice and Hulsemann, 1965---- 33
307. *Z. crassa*, new species---- 41

ACARTIIDAE
308. *Acartia danae* Giesbrecht, 1889 ..... 38, 42, 45
309. *A. negligens* Dana, 1849 ..... 5, 31, 32, 34, 36, 38–40, 43–45, 48
INCERTAE SEDIS
310. Male 41

***Calanus australis* Brodsky, 1959**

FIGURE 3

Remarks: In dorsal view the slightly produced anterior end of the head and the narrow fifth thoracic segment make the specimen referable to Brodsky's *C. australis* var. *atlanticus*. Brodsky (1959) suggests that this is a species of temperate latitudes in the Southern Hemisphere. The single specimen was found in the Bé net sample at 35°09′ S, 69°59′ E. This is the first record of *C. australis* from the Indian Ocean.

***Farrania frigida* (Wolfenden, 1911)**

FIGURES 4–15

Diagnosis (male): Fifth thoracic segment small and rounded. First antenna reaches to end of furca, segments 20–21 (fused) and 22 of right antenna each with patch of thick hair. Proximal end of first antenna highly setose and provided with aesthetasks. Fifth feet asymmetrical, right foot longer than left one. Right exopod 3-segmented, terminal segment provided with 2 terminal setae and subterminal hair. Endopod represented by small, bulblike protuberance. Left exopod 3-segmented. Two unequal spines on terminal segment and one spine on distal lateral corner of first segment. Endopod consists of small rounded protuberance. Total length 2.34 mm.

Remarks: The male of this species, not heretofore known, is distinguished from the male of *F. orbus* (Tanaka) by the rounded fifth thoracic segment and the structure of the fifth feet.

***Mimocalanus inflatus?* Davis, 1949**

FIGURES 16–18

Remarks: As the swimming feet are broken off in both specimens examined it is not possible to determine whether the second endopodal segments are inflated as they are in Pacific and Atlantic specimens of *M. inflatus*. The Indian Ocean specimens have five setae on the second inner lobe and four setae on the second basal segment of the first maxilla. There are four setae and five setae on the corresponding structures of the second maxilla of the Atlantic Ocean specimen described by Grice and Hulsemann (1965). The total length of the present specimens is 1.76 and 2.01 mm. *Mimocalanus inflatus* has not previously been reported from the Indian Ocean.

***Mimocalanus* species**

FIGURES 19–25

Remarks: We are tentatively assigning the two males to this genus. The fifth feet are uniramous and styliform. The terminal segments of the exopods each have a long spine. The fifth feet of *M. cultrifer* and *M. nudus* are not so elongate and the terminal segments of the exopods have short spines. The total length of both specimens is .78 mm.

***Spinocalanus longipes* Tanaka, 1956**

FIGURES 26–27

Remarks: We are referring three male specimens to this species although, as Johnson (1963) points out, the fifth pair of feet is most unlike any described *Spinocalanus*. The total length of the three specimens ranges from 1.60 to 1.76 mm. *Spinocalanus longipes* has not previously been reported from the Indian Ocean.

***Spinocalanus magnus* Wolfenden, 1904**

Remarks: Small differences were noted in the ornamentation (hair, spines) of the terminal exopodal segments of the fifth feet of the present male and that described by Tanaka (1956). The total length of our two male specimens is 2.00 mm.

***Spinocalanus validus* Sars, 1905**

FIGURES 28–31

Diagnosis (male): Anterior end of head knoblike, lateral margin of third thoracic segment with protuberances. Exopods and endopods of fifth feet very elongate, second and third right exopodal segments pubescent. Total length 5.08 mm.

Remarks: The male of this species, heretofore unknown, is distinguished by its large size and details of the fifth feet. Our findings of *Spinocalanus validus* constitute a new record for the Indian Ocean.

***Spinocalanus ventriosus*, new species**

FIGURES 32–34

Occurrence: Station 332 NV, 2000 to 1002 m, 2 ♀♀; 332 NV, 3000 to 2000 m, 3 ♀♀; 338 NV, 2000 to 1000 m, 2 ♀♀; 340 NV, 2950 to 1990 m, 1 ♀; 349 NV, 2000 to 1000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment incompletely separated, fifth thoracic segment ends in rounded protrusions. First maxilla with four setae on second inner lobe, three on third inner lobe, four on second basal segment and nine on endopod. Total length 1.32–1.52 mm. Female from station 349 is holotype. Holotype: USNM 113513.

Remarks: The knoblike protrusions of the fifth thoracic segment and the number of setae on the first maxilla will distinguish this species from *S. polaris* Brodsky, a species it resembles.

Spinocalanus species

FIGURE 35

Remarks: A single male specimen with fifth feet similar to *S. longipes* is here tentatively referred to the genus *Spinocalanus*. The left exopod is greatly elongate and the endopod is rudimentary. The right foot is small, 1-segmented, and does not exceed the second basal segment of the left foot. The total length of the specimen is 1.28 mm.

Teneriforma, new name

Teneriforma naso, new combination

FIGURES 36–38

Tanyrhinus naso Farran, 1936, pp. 86–87, text-fig. 4.

Diagnosis (male): Head and first thoracic segment separate, fourth and fifth thoracic segments separate. Furca approximately equal to combined length of fourth and fifth abdominal segments. Rostrum large and curved posteriorly. First antenna with 24 free segments (8 and 9 fused), reaching to end of furca. Fifth feet uniramous and asymmetrical. Left foot elongate and consisting of five segments. Right foot small and consisting of two segments. Total length .92 mm. USNM 113514.

Remarks: The male of this monotypic genus has not previously been described. Since the name *Tanyrhinus* has been used for a genus of insects (Coleoptera) by Mannerheim in 1852 (Bull. Soc. Imp. Nat. Moscou, vol. 25, no. 2, p. 349), the genus is here renamed *Teneriforma*. This is the first record of *Teneriforma naso* from the Indian Ocean.

Aetideopsis retusa, new species

FIGURES 39–45

Occurrence: Station 342 NV, 3000 to 1980 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment incompletely separate. Fourth and fifth thoracic segments separate. Rostrum distinct, rami separated by deep invagination. Frontal organ prominent and visible in dorsal view. Posterior lateral corner of fifth thoracic segment acutely pointed. First antenna exceeds furca by last two segments. Total length 1.96 mm. Holotype: USNM 113515.

Remarks: This species is distinguished from others in the genus by its small size and long first antenna.

Bradyetes florens, new species

FIGURES 46–54

Occurrence: Station 338 NV, 2000 to 1000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment incompletely separate, fourth and fifth thoracic segments separate. Fifth thoracic segment rounded. Rostrum absent. First antenna reaches to end of furca. Terminal five segments of maxilliped equal in length to second basal segment. First and second exopodal segments of first foot without external spines. Total length 1.10 mm. Holotype USNM 113516.

Remarks: This species differs from *B. inermis* Farran and *B. brevis* Farran, the only described species in this genus, by the relatively short first and second basal segments of the maxilliped, by the absence of a spine on the first exopodal segment of the first foot, and by its small size.

Chirundinella cara Tanaka, 1957

FIGURE 55

Remarks: The only difference between this specimen and the description given by Tanaka (1957) are 11 rather than 10 setae on the endopod of the first maxilla and 3 rather than 4 setae on the fifth lobe of the second maxilla. Our specimen measured 7.80 mm, Tanaka's measured 7.44 mm. This species has not heretofore been found in the Indian Ocean.

Gaetanus brachyurus Sars, 1907

Remarks: The female specimen from station 131 differs from the others and from the description of this species in having the exopod of the first foot consisting of two segments. Each segment has one external spine. The animal is also smaller (5.00 mm). The other two females found measured 6.17 and 6.42 mm. *Gaetanus brachyurus* has not previously been found in the Indian Ocean.

Gaetanus ferox With, 1915

FIGURES 56-59

Remarks: Although the right exopod of the fifth foot of the male is 3-segmented in our specimen (With, 1915, shows two segments), the terminal portion of the exopod is similar to With's figure. Possibly the suture separating the two terminal segments was not observed by him. Our specimen measured 3.55 mm; With's measured 3.4 mm. This species has not previously been reported from the Indian Ocean.

Gaidius robustus (Sars, 1905)

FIGURES 60-64

Gaetanus robustus Sars, 1905a, pp. 11-12.
Gaidius maximus Wolfenden, 1906, p. 35, pl. 11, figs. 1, 2.
Gaidius validus Farran, 1908, pp. 32-33, pl. 2, figs. 11-17.
Mesogaidius maximus (Wolfenden).—Wolfenden, 1911, pp. 224-226, pl. 26, figs. 3-6, text-fig. 13.
Pseudogaetanus robustus (Sars).—Brodsky, 1950, pp. 168-169, fig. 86.
not *Gaidius robustus* Vervoort, 1949, pp. 12-15, figs. 5, 6.

Remarks: Vervoort (1952a, 1952b) redefined the genera *Gaidius* Giesbrecht and *Gaetanus* Giesbrecht. Accordingly, the species Sars described in 1905 as *Gaetanus robustus* is here transferred to the genus *Gaidius*. Brodsky (1950) proposed a new genus, *Pseudogaetanus*, for this species. In our opinion, the characters given are insufficient for the erection of a new genus.

The paratype of *Gaidius robustus* Vervoort was kindly loaned to us for examination. We concur with Dr. Vervoort (in litt.) that the specimen is actually referable to *G. intermedius* Wolfenden, the latter species name having priority.

Gaidius robustus (Sars) has not previously been reported from the Indian Ocean.

Pseudochirella gibbera Vervoort, 1949

Remarks: None of the specimens had a spine on the right dorsal side of the fifth thoracic segment as described by Vervoort (1949) in the original description of the species. Our specimens varied in total length from 5.83 to 6.17 mm. Vervoort's single specimen measured 5.50 mm. The species has not been reported from the Indian Ocean.

Pseudochirella squalida, new species

FIGURES 65–70

Occurrence: Station 351B IK, 350 to 1710 m, 1 ♀.

Diagnosis (female): Rostrum strong and directed ventrally. Fifth thoracic segment rounded. First antenna reaches furca. Second endopodal segment of second antenna with seven setae on outer lobe and nine setae on inner lobe. First basal segment of fourth foot with six coarse spines. Genital segment slightly asymmetrical and hairy. Small rounded protuberances on each side. Total length 5.66 mm. Holotype: USNM 113517.

Remarks: This species resembles *P. obesa* Sars but may be distinguished from it by the protuberances on the genital segment. The genital segment of *P. obesa* has neither protuberances nor hair.

Euchaeta robusta (Wolfenden, 1911)

Remarks: Our female specimen differs from Wolfenden's (1911) original description by the absence of hair on the fifth thoracic segment and by a longer second abdominal segment. The first three abdominal segments have a relative length of 20:10:10. Wolfenden gave a ratio of 20:17:15 for his specimens. Our specimen measured 7.85 mm, Wolfenden's 7.8 mm.

Xanthocalanus hispidus, new species

FIGURES 71–79

Occurrence: Station 355 NV, 2000 to 1000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment fused, fourth and fifth thoracic segments incompletely separate. Ratio of cephalothorax to abdomen 4:1. Posterior lateral corner of fifth thoracic segment somewhat protruded and rounded. Rostral filaments present. First maxilla with two setae on second inner lobe, two setae on third inner lobe, two setae on second basal segment, eight setae on endopod and five setae on exopod. Second maxilla with sensory appendages, coarse setae broken off. Maxilliped setose. Spines on external margin of exopods of first foot long and seta-like. Exopods and endopods of second through fourth feet broken off. Fifth feet 2-segmented. Distal segment with three spines and one spinelike protrusion. Scattered spines on surface of segment and at junction of first and second segment. Total length 1.00 mm. Holotype: USNM 113518.

Remarks: This species resembles *X. paraincertus* Grice and Hulsemann, but the two may be distinguished by the segmentation and structure of the fifth feet. *X. hispidus* has 2-segmented fifth feet and two short outer spines on the terminal segment. *X. paraincertus* has 3-segmented fifth feet and two long outer spines on the terminal segment.

Amallothrix indica Sewell, 1929

FIGURES 80–82

Diagnosis (male): Left fifth foot nearly twice as long as abdomen. Basal segments of left foot very elongate, exopod 3-segmented, endopod 2-segmented. Right foot only slightly longer than first basal segment. Exopod 2-segmented, endopod 1-segmented. Total length 2.68–3.10 mm.

Remarks: The male of this species resembles *Amallothrix emarginata* (Farran) but the right exopod of the latter species exceeds the length of the left exopod. In *A. indica* the right exopod is quite short. The male of this species has not heretofore been described.

Amallothrix paravalida Brodsky, 1950

FIGURES 83–84

Diagnosis (male): The terminal segment of the left fifth foot has two rows of spines and a rounded lamella. Total length 2.30 mm.

Remarks: We are tentatively referring to this species a single male specimen found in a sample containing two female *A. paravalida*. The structure of the terminal segment of the left fifth foot of the male of *A. paravalida* will distinguish this species from *A. valida* (Farran).

Amallothrix robustipes Grice and Hulsemann, 1965

Remarks: The present specimens have 2 setae on the second inner lobe and 10 setae on the endopod of the first maxilla. The two Atlantic Ocean specimens described by Grice and Hulsemann (1965) have four setae on the second inner lobe and nine setae on the endopod of the first maxilla. There are no rostral filaments on the Indian Ocean specimens whereas there are two on the Atlantic Ocean ones. The total length of the specimens is 1.00 and 1.20 mm. This is the first record of *Amallothrix robustipes* in the Indian Ocean.

?*Racovitzanus* species

FIGURES 85–95

Diagnosis (male): Head and first thoracic segment separate, fourth and fifth thoracic segments separate. Posterior lateral corner of fifth thoracic segment indented. Abdominal segments elongate. Rostrum large, without filaments. First antenna exceeds furca by last segment. Segments 8–10 of right first antenna fused. First and second maxilla of the type present in family Scolecithricidae. Maxilliped greatly reduced and with few setae. Exopods of the fifth feet 3-segmented, endopods 1-segmented and pointed. Total length 1.92 mm.

Remarks: We are tentatively assigning this male to the genus *Racovitzanus* based largely on the shape of the rostrum. Since it may represent the undescribed male of a known species, we are not describing it as new species.

Scaphocalanus bogorovi Brodsky, 1955

FIGURES 96–99

Remarks: The present specimens agree with those collected by us in the North Atlantic (Grice and Hulsemann, 1965). The range of this species is here extended to the Indian Ocean.

Scolecithricella grata, new species

FIGURES 100–103

Occurrence: Station 131 Bé, 2000 to 1000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment fused, fourth and fifth thoracic segments fused. Rostral filaments present. First maxilla of usual scolecithricid structure. Second maxilla with four lobes each bearing setae and without terminal sensory appendages. Fifth feet consisting of one segment ending in a long spine. Total length 1.31 mm. Holotype: USNM 113521.

Remarks: This species differs from others in the genus by the structure of the fifth feet and the absence of sensory appendages on the second maxilla. In the latter respect it is similar to *Scolecithrix fowleri* Farran.

Scolecithricella maritima, new species

FIGURES 104–114

Occurrence: Station 332 NV, 2000 to 1002 m, 2 ♀♀; 340 NV, 1950 to 1015 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment fused, fourth and fifth thoracic segments incompletely separate. Anterior margin of head broadly rounded. Rostral filaments absent. First antenna with 23 free segments (segments 8 and 9 fused), reaching to fifth thoracic segment. Mouth appendages of *Scolecithricella* type. Expods of first through fourth swimming feet 3-segmented, endopod of first foot 1-segmented, of second foot 2-segmented, of third and fourth feet 3-segmented. Scattered spines on terminal endopodal segments of second through fourth feet. Fifth feet 3-segmented with one terminal and one internal spine on distal segment. Total length .76–.77 mm. One female from station 332 is the holotype. Holotype USNM 113522.

Remarks: This species is similar to *S. ctenopus* (Giesbrecht), but the two may be distinguished by the structure of the fifth feet and by their size. *S. maritima* has no surface spines on the second and third segments of the fifth feet and the total length is less than 1 mm. *S. ctenopus* has numerous small spines in the second and third segments of the fifth feet and the total length is about 1.50 mm.

Scolecithricella timida Tanaka, 1962

FIGURES 115-123

Remarks: This species was originally described from Sagami Bay, Japan (Tanaka, 1962). Some additional figures are given here. The total length of the specimens varies from 1.50 to 1.76 mm. This species has not been reported from the Indian Ocean.

***Scolecithricella* species**

FIGURES 124–125

Diagnosis (male): Head and first thoracic segment fused, fourth and fifth thoracic segments separate. First antenna reaches end of second abdominal segment. Right fifth foot uniramous, 2-segmented. Left foot biramous, exopod 3-segmented, endopod 1-segmented. Total length .72 mm.

Remarks: The single male specimen is probably referable to a described female of this species. We therefore will not offer it as a new species.

***Scolecithrix fowleri* Farran, 1926**

FIGURES 126–129

Diagnosis (male): Head and first thoracic segment fused, fourth and fifth thoracic segments separate. Large, ventrally directed rostrum. Fifth feet biramous. Right foot with 3-segmented exopod, 2-segmented endopod. Left foot with 3-segmented exopod and 1-segmented endopod. Total length 1.62 mm.

Remarks: The male of this species has not been heretofore known. Our findings of *Scolecithrix fowleri* represent a new record for the Indian Ocean.

***Metridia boecki?* Giesbrecht, 1889**

FIGURES 130–133

Diagnosis (male): Head and first thoracic segment fused, fourth and fifth thoracic segments fused. Posterior lateral corner of fifth thoracic segment with small protuberance. First antenna reaches to end of second abdominal segment. First segment of left first foot with pubescent swelling. Total length 1.95–2.01 mm.

Remarks: The five male specimens here tentatively recognized as belonging to *M. boecki* differ slightly from *M. discreta* by the large swelling on the first segment of the left fifth foot.

***Metridia brevicauda* Giesbrecht, 1889**

Remarks: The fifth pair or feet of several female specimens were observed to have four rather than three segments. In other respects they agreed with *M. brevicauda.*

***Metridia effusa*, new species**

FIGURES 134–143

Occurrence: Station 108 Bé, 2000 to 1000 m, 1 ♀; 134 Bé, 2000 to 1000 m, 11 ♀♀, 6 ♂♂; 140 Bé, 2000 to 1000 m, 2 ♀♀.

Diagnosis (female): Head and first thoracic segment incompletely separate, fourth and fifth thoracic segments fused. Anterior end of head pointed, posterior lateral corner of fifth thoracic segment rounded.

Genital segment short, in dorsal view sides parallel. Furca longer than wide. First antenna reaches genital segment. First and second segments with prominent teeth. Fifth feet 3-segmented, with extremely small distal segment bearing a long seta. Penultimate segment with small distolateral spine. Total length 1.58–1.79 mm. Holotype: USNM 113525.

Diagnosis (male): Head and first thoracic segment fused, fourth and fifth thoracic segments fused. Anterior end of head with rounded knob. Posterior lateral corner of fifth thoracic segment rounded. Internal spine on second segment of right foot reaches just beyond middle of distal segment. Third segment of left foot with one seta and one spine on internal side. Total length 1.36–1.44 mm. Allotype: USNM 113526.

Remarks: The female of this species resembles *M. venusta* Giesbrecht and *M. brevicauda* Giesbrecht. From the former it is distinguished by the 3-segmented fifth feet and presence of one terminal seta on the distal segment. *M. venusta* has a 2-segmented fifth foot and four setae on the distal segment. From *M. brevicauda* it is distinguished by the spines on the first and second segments of the antenna; in addition, neither *M. venusta* nor *M. brevicauda* have pointed foreheads. The male is distinguished from these species by the rounded knob on the anterior margin of the head and the details of the fifth feet.

Lucicutia major Wolfenden, 1911

FIGURES 144–147

Remarks: This species has not been reported since it was described by Wolfenden in 1911. The one female found differs from the description in that the first antenna exceeds the end of the furca by about the last four segments. Wolfenden stated that the antenna exceeds the furcae by the last two segments. Also, the left furca is only slightly longer than the right one instead of being considerably longer as mentioned in the original description. In all other points our specimen agrees with the description of Wolfenden. The present specimen measures 8.16 mm; Wolfenden's measured 8.0–8.2 mm. Since no figures of *Lucicutia major* have been published, we are presenting figures of this species here. This is the first record of *L. major* from the Indian Ocean.

Disco inflatus Grice and Hulsemann, 1965

FIGURES 148–161

Diagnosis (male): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Anal segment longer than

preceding segment, slightly shorter than furca. Rostrum absent. First antenna reaches to fourth segment of abdomen. Left antenna geniculate. Endopod of second antenna about equal in length to exopod. First endopodal segment of mandible with row of spines. Mandible palpus elongate, blade with two subequal teeth. First maxilla reduced, endopod (?) with two setae. Second maxilla and maxilliped with reduced number of setae. Exopods of swimming feet 3-segmented, endopod of first foot 2-segmented, of second to fourth feet 3-segmented. Spine of first exopodal segment of first foot large and elongate. Fifth feet biramous, exopods 3-segmented, endopods 2-segmented. Penultimate segment of left exopod indented on internal side. Total length 1.16 mm.

Remarks: The genus *Disco* was described by us (Grice and Hulsemann, 1965) on the basis of female specimens collected in the North Atlantic Ocean. *D. inflatus* has not been previously reported from the Indian Ocean.

Disco species

FIGURES 162–173

Diagnosis (male): Head and first thoracic segment incompletely separate, fourth and fifth thoracic segments fused. Anal segment longer than preceding segment and furca. Rostrum absent. Left antenna geniculate. Endopod of second antenna ⅔ the length of exopod. Mandible palpus elongate, blade with spinelike hairs and three spiniform teeth. First maxilla well developed, internal lobe bearing one seta, exopod with four setae, and second basal segment with one seta. Second maxilla and maxilliped with reduced number of setae. Exopods and endopods of first and second feet 3-segmented. Third and fourth feet broken off. Fifth feet biramous, exopods 3-segmented. Endopod of right foot 3-segmented, of left foot 2-segmented. Total length .80 mm.

Remarks: It appears that the present specimen is referable to the genus *Disco*, but probably not to either of the two described species (*D. longus*, *D. minutus*) in which the male is unknown. The present male differs from these two species in the absence of a rostrum and in the segmentation of the endopods of the first and second swimming feet. It seems preferable not to refer the male to either species as it may represent the male of an undescribed species of *Disco*.

Euaugaptilus brodskyi Hulsemann, 1967

FIGURES 174–179

Remarks: We found one female measuring 6.83 mm in length, which we believe is *Euaugaptilus brodskyi*. The mandible, first and

second maxilla are figured here since Brodsky (1950) did not figure all of the appendages. In our specimen the exopod of the mandible palpus is reduced and bears four setae. The endopod is represented by one seta. Brodsky described this species as *E. mixtus*. The name was subsequently changed (Hulsemann, 1967) to *E. brodskyi* because it was preoccupied by a species described by Sars in 1905.

There was one male in the collection which measured 3.33 mm. In the structure of the mandible blade and the first maxilla it is closer to the female of *Euaugaptilus mixtus* Brodsky as described and figured by Tanaka (1964) than to the specimens originally described by Brodsky. In our specimen the mandible palpus is biramous. The number of setae on lobes 1–6 of the second maxilla is 1, 1, 2, 3, 2, 3, respectively, and that on lobes 1–5 of the maxilliped is 1, 3, 3, 2, 2, respectively. This male is identical to the one reported as *Euaugaptilus* species by Grice and Hulsemann (1965) from the northeastern Atlantic Ocean. *Euaugaptilus brodskyi* has not previously been reported from the Indian Ocean.

***Euaugaptilus curtus*, new species**

FIGURES 180–186

Occurrence: Station 108 Bé, 2000 to 1000 m, 1 ♀, 1 ♂.

Diagnosis (female): Body slender, head and first thoracic segment incompletely separate. Fourth and fifth thoracic segments fused, posterior lateral corners rounded. Abdomen 3-segmented, genital segment longer than the two following combined. Rostrum with two slender filaments. First antenna exceeds end of furca by about five segments. Exopod of second antenna consisting of eight segments, reaching to end of first endopodal segment. Mandible palpus uniramous composed of five segments, the last three each bearing one seta. Mandible blade with two strong double teeth and one smaller tooth adjacent to the seta. First inner lobe of first maxilla with six spines, second and third inner lobes rudimentary. Fused second basal segment and endopod with one seta. Exopod carrying one very long and one small terminal seta and one slender subterminal seta. External lobe with two setae. Number of setae on lobes 1–6 of second maxilla: 3, 2, 2, 3, 2, 3, respectively; 7 setae on the endopod. Maxilliped bearing 1, 3, 3, 2, 2 setae on the lobes of the basipod. Exopods and endopods of first to fifth pair of swimming feet 3-segmented. Total length 2.81 mm. Holotype: USNM 113528.

Diagnosis (male): Differs from female in the following: Abdomen consisting of five segments. Left first antenna geniculate. Segmentation of mandible palpus incomplete. First inner lobe of first maxilla with five spines. Fifth feet as in figure 186. Total length 2.49 mm. Allotype: USNM 113529.

Remarks: *Euaugaptilus curtus* resembles *E. longiseta* Grice and Hulsemann. The former species differs from the latter, however, in having two teeth on the mandible blade, a uniramous mandible palpus, and a more reduced first maxilla.

***Euaugaptilus fundatus*, new species**

FIGURES 187–192

Occurrence: Station 108 Bé, 2000 to 1000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Posterior lateral corner of fifth thoracic segment rounded. Abdomen 3-segmented. Genital segment longer than the two following combined. Rostral filaments slender, broken short. First antenna exceeding end of furca by about last three segments. Exopod of second antenna 8-segmented. Mandible palpus biramous, endopod small, ending in one setae. Mandible blade with two strong teeth, each with a small side tooth, and one large seta. First inner lobe of first maxilla with four spines; second and third inner lobes absent; fused second basipodal segment and endopod with one seta; exopod with five setae, the two terminal ones largest; external lobes with five setae, the middle one being the largest. Number of setae on lobes 1–6 in the second maxilla: 3, 2, 2, 2, 2, 1, respectively. Two setae each on lobes 3–5 of the maxilliped. Exopod of first swimming foot consisting of three segments, endopod of two segments. Groups of small hairs near base of external spines of second and third exopodal segments. Exopods and endopods of second to fifth swimming feet 3-segmented. Total length 3.64 mm. Holotype: USNM 113530.

Remarks: *Euaugaptilus fundatus* resembles *E. longiseta* Grice and Hulsemann and *E. curtus*. It is distinguished from these by the structure of the mandible blade and palpus, and the development of the first and second maxilla.

***Euaugaptilus humilis* Farran, 1926**

Remarks: These specimens agree in those details discussed by Grice (1963): presence of rostral filaments, symmetrical furcae, symmetrical genital segment, and the presence of a second inner lobe on the first maxilla. *Euaugaptilus humilis* has not previously been reported from the Indian Ocean.

***Euaugaptilus longiseta* Grice and Hulsemann, 1965**

FIGURES 193–195

Diagnosis (male): Rostrum small with slender filaments. Right furca shorter than left. First antenna exceeds end of furca by last four segments. Exopod of second antenna 7-segmented. Mandible palpus biramous, blade as in female. First maxilla with one seta

on fused second basal segment and endopod, five setae on exopod. Number of setae on lobes 1–6 of second maxilla: 2, 2, 2, 3, 2, 1 respectively. Number of setae on lobes 1–5 of maxilliped: 1, 2, 3, 2, 2. Exopods and endopods of fifth feet 3-segmented, terminal segments with one long seta and one short spine. Total length 1.82 mm.

Remarks: Although the first maxilla of the male has no second inner lobe and fewer setae on the fused second basal segment and endopod (one rather than three setae as in the female), the other head appendages agree well with those of the female. The male has not heretofore been described. Our findings of *Euaugaptilus longiseta* represent a new record for the Indian Ocean.

***Euaugaptilus malacus*, new species**

FIGURES 196–200

Occurrence: Station 134 Bé, 2000 to 1000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Posterior lateral corner of fifth thoracic segment rounded, set off by a slight indentation. Abdomen 3-segmented. Rostral filaments very slender. First antenna exceeds end of furca but broken off at segment 22. Exopod of second antenna 8-segmented, shorter than endopod. Mandible blade obliquely cut bearing two strong double-teeth and two slender, shorter teeth. Endopod of mandible palpus rudimentary. First inner lobe of first maxilla with six rather slender and elongate spines, second inner lobe with one seta, third inner lobe lacking; fused second basal segment and endopod with one seta; exopod with two strong and one weak seta; external lobe with three setae. Number of setae on lobes 1–6 of second maxilla: 0, 1, 2, 2, 2, 1, respectively. Number of setae on first five lobes of maxilliped: 1, 2, 3, 2, 2, respectively. Endopods and exopods of first through fifth pair of swimming feet 3-segmented. Total length 3.29 mm. Holotype: USNM 113532.

Remarks: *Euaugaptilus malacus* resembles *E. facilis* (Farran). The obliquely cut mandible blade, the rudimentary endopod of the mandible palpus, the lack of a blunt process on the outer margin of the second and third exopodal segments of the third and fourth swimming feet, and the small size of *E. malacus* will distinguish it from *E. facilis*.

***Euaugaptilus nodifrons* (Sars, 1905)**

FIGURES 201–203

Remarks: A dorsal view of the body, rostrum, and mandible blade of the male are illustrated for the first time. Other appendages of the male are shown by Sars (1924–25) and Sewell (1929).

Euaugaptilus oblongus (Sars, 1905)

Augaptilus oblongus Sars, 1905b, pp. 11–12.
Augaptilus rostratus Esterly, 1906, p. 73, pls. 9 (fig. 19), 11 (fig. 42), 12 (figs. 57, 63), 13 (fig. 75).
Augaptilus subfiligerus Wolfenden, 1911, p. 343.
Euaugaptilus oblongus (Sars).—Sars, 1924–1925, pp. 266–267, pl. 81.
Euaugaptilus rostratus (Esterly).—Brodsky, 1950, pp. 374–375, fig. 264.

Remarks: Close examination of two females of *Euaugaptilus rostratus* (loaned to us by Scripps Institution of Oceanography) on which Esterly (1906) probably based the description of that species indicates that *E. rostratus* (Esterly) is identical to *E. oblongus* (Sars, 1905). A comparison of the description of *Augaptilus subfiligerus* Wolfenden, 1911, with *E. oblongus* (Sars) shows that these two species are also identical.

The synonymy of the three species extends the size range of *Euaugaptilus oblongus* to 4.65–7.4 mm.

Euaugaptilus quaesitus, new species

FIGURES 204–209

Occurrence: Station 332 NV, 3000 to 2000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Posterior lateral corner of fifth thoracic segment rounded. Abdomen 3-segmented. Genital segment longer than the two following combined. Rostrum consisting of two points, rostral filaments absent. First antenna barely reaching furca. Exopod of second antenna 8-segmented, segments seven and eight incompletely separated; exopod and endopod of equal length. Mandible blade with two widely separated strong teeth and one slender tooth near the seta. First inner lobe of first maxilla with four spines; second and third inner lobes absent; fused second basipodal segment and endopod with one seta; exopod with five setae, the two terminal ones largest; external lobe with three setae of equal length. Number of setae on lobes 1–6 of the second maxilla: 2, 2,1, 2, 2, 1, respectively. Number of setae on lobes 1–5 of the maxilliped: 0, 3, 3, 2, 2, respectively. Exopod of first swimming foot consisting of three segments, endopod of two segments. Exopods and endopods of second through fourth pair of swimming feet 3-segmented. Exopod and endopod of fifth pair 2-segmented. Total length 1.40 mm. Holotype: USNM 113533.

Remarks: *Euaugaptilus quaesitus* resembles *E. fundatus* in the structure of the mandible blade, the first maxilla, and the 2-segmented endopod of the first swimming foot. The two species can be sepaby the smaller size of *Euaugaptilus quaesitus* and by its lack of rostral filaments, its shorter first antenna, and its 2-segmented exopod and

endopod of the fifth feet. *E. quaesitus* is also close to *Euaugaptilus hecticus* (Giesbrecht), but the shorter first antenna in *E. quaesitus* and the more developed mandible palpus and blade distinguish these two species. Finally, *E. quaesitus* differs from *E. humilis* Farran in its shorter first antenna and the structure of the mandible blade and the first maxilla.

***Euaugaptilus rectus*, new species**

FIGURES 210–214

Occurrence: Station 337B IK, 275 to 2250 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Posterior lateral corner of fifth thoracic segment rounded. Rostrum consisting of two short and stout cones. No rostral filaments. Exopod of second antenna 8-segmented. Mandible palpus with well-developed rami. Mandible blade obliquely terminated. First maxilla with one seta on second inner lobe, no seta on third inner lobe, three setae on fused second basal segment and endopod, and four setae on exopod. Second maxilla with following setae number on lobes 1–6: 2, 1, 1, 3, 2, 3. Number of setae on lobes 1–5 of maxilliped: 1, 3, 3, 2, 2. Exopod of first foot with one external spine on first segment, one external spine on second segment and two external spines on third segment. Total length 7.98 mm. Holotype: USNM 113534.

Remarks: This species is similar to *E. angustus* (Sars) but the two may be separated by the structure of the rostrum (2-pointed in *E. rectus*, rounded in *E. angustus*), and first foot (two external spines in *E. rectus*, one spine in *E. angustus*).

***Euaugaptilus* species 1**

FIGURES 215–224

Diagnosis (female): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Genital segment more than one-half the length of the abdomen. Rostral filaments small and fine. First antenna exceeds furca by last five segments. Exopod of second antenna 8-segmented. Mandible palpus without rami. First maxilla with one seta on second inner lobe, no seta on third inner lobe, one seta on fused second basal segment and endopod, and four setae on exopod. Number of setae on lobes 1–6 of the second maxilla: 2, 2, 2, 3, 2, 3, respectively. Number of setae on lobes 1–5 of maxilliped: 1, 3, 3, 2, 2. Maxilliped with indented knob on posterior side. Exopods and endopods of first through fourth feet 3-segmented. Third exopodal segment of third foot cup shaped with two rudimentary spines on external margin and five setae on internal margin. Fifth feet with 3-segmented exopods and endopods and with a small spine on the inne side of the second exopodal segment. Total length 4.87 mm.

228-966—67——4

Remarks: There is reasonably good agreement between the present specimen and *E. facilis* (Farran), a species also found in these collections. They differ chiefly in the structure of the mandible (no rami in *Euaugaptilus* species 1, biramous in *E. facilis*), first maxilla (three large and one small setae on the exopod in *Euaugaptilus* species 1, three large setae on exopod of *E. facilis*), and third pair of feet (enlarged terminal exopodal segments in *Euaugaptilus* species 1, usual type of terminal segment in exopods in *E. facilis*). The present specimen could possibly be an abnormally developed *E. facilis* and we have therefore not considered it a new species.

***Euaugaptilus* species 2**

FIGURES 225–230

Diagnosis (male): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Posterior lateral corner of fifth thoracic segment rounded. Abdomen consisting of five segments, anal segment very long, longer than furca. Large rostrum rounded. Rostral filaments slender. Right first antenna reaching anal segment; left first antenna geniculate. Exopod of second antenna 8-segmented, small, extending to two-thirds of first segment of endopod. Mandible blade with four strong and one slender tooth of about the same length, seta small. Mandible palpus biramous. First maxilla much reduced; first endopodal lobe with one spine, second endopodal lobe with one spine, third lobe absent; fused second basal segment and endopod with one seta; exopod with two rather strong setae; external lobe without setae. Number of setae on lobes 1–6 of second maxilla: 1 and a small process, 1 (?), 2, 2, 2, 1, respectively. Number of setae on first 5 lobes of maxilliped: 1, 1, 2, 2, 2, respectively. Exopods and endopods of first to fifth pair of swimming feet 3-segmented. Seta on second basipodal segment of fifth foot short; inner margin of second exopodal segment of right fifth foot with process near proximal corner; external spines of first and second exopodal segments with small knoblike protrusions apically near their base. Total length 3.7 mm.

Remarks: The structure of the mandible and the first maxilla as well as the relatively long genital segment suggest a close relationship of *Euaugaptilus* species 2 to *E. affinis* Sars. The one male specimen found differs from Sars' description (1924–25) of the female in a reduced number of spines or setae, respectively, on the first inner lobe and the outer lobe of the first maxilla, second maxilla and the maxilliped. Also, this male (total length 3.77 mm) is smaller than the female of *E. affinis* (5.40 mm). The male of *E. affinis* is undescribed.

The characteristics pointed out by Brodsky (1950) to distinguish his *Euaugaptilus pseudaffinis* from *E. affinis*—i.e., differences in the

length of the first and second antenna and the structure of the fifth pair of feet—seem insufficient to distinguish *E. pseudaffinis* Brodsky from *E. affinis* Sars. No difference is obvious between Brodsky's and Sars' figure of the fifth feet of the female.

***Euaugaptilus* species 3**

FIGURES 231–240

Diagnosis (male): Head and first thoracic segment fused, fourth and fifth thoracic segments fused. Anal segment twice the length of the preceding segment. Rostrum knoblike , with two short filaments. First antenna exceeds furca by last two segments, left antenna geniculate. Endopod of second antenna about four times longer than exopod. Mandible palpus small, uniramous. First maxilla much reduced. Distal setae of second maxilla and maxilliped with numerous "buttons." Swimming feet with 3-segmented exopods and endopods. Total length 6.16 mm.

Remarks: We are unable to refer this male to a described species but it may be the undescribed male of a known species. The head appendages resemble those of the female of *E. rigidus* (Sars), but the size of the present male exceeds that of the female.

***Pachyptilus abbreviatus* (Sars, 1905)**

FIGURES 241–247

Remarks: Figures of the female of this species, not previously known from the Indian Ocean, are given here. The total length is 5.52 mm.

***Pachyptilus pacificus* Johnson, 1936**

Pachyptilus eurygnathus Sars.—Sewell, 1947, p. 239, text-fig. 65.

Remarks: The species reported by Sewell (1947) as *P. eurygnathus* is referable to *P. pacificus*. Sewell's specimen has a 2-segmented exopod on the first feet, which is the same number found in *P. pacificus*.

***Pontoptilus robustus* Sars, 1905**

FIGURES 248–258

Diagnosis (female): Head and first thoracic segment separate, fourth and fifth thoracic segments fused, posterior lateral corner of fifth thoracic segment protruded. Rostrum absent. First antenna consisting of 25 free segments, exceeding furca by last 3 segments. Structure and setation of head and thoracic appendages similar to *P. muticus* Sars. Total length 8.51 mm.

Remarks: Although closely resembling *P. muticus*, *P. robustus* is distinguished by its larger size, long antenna, and protruding fifth thoracic segment. The female has not been described heretofore. The male was described by Sars in 1905 and later illustrated by him

(Sars, 1924–25). This is the first record of *Pontoptilus robustus* in the Indian Ocean.

***Pontoptilus lacertosus*, new species**

FIGURES 259–265

Occurrence: Station 347A, IK, 350 to 2500 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment fused, fourth and fifth thoracic segments fused. Fifth thoracic segment rounded. Rostrum robust with a single point. First antenna exceeding furca by about five segments. Mandible palpus with three setae. Blade resembling that of *P. ovalis* Sars. First maxilla with five setae on second inner lobe, four setae and a small spine on the endopod, two setae on the second basal segment, five setae on the endopod, three setae on the exopod and one seta on a lobe located just ventrad of the exopod. Setae on lobes 1–5 of the second maxilla as follows: 8, 3, 3, 3, 3, respectively. First to fourth swimming feet with 3-segmented exopods and endopods. Fifth feet with 3-segmented exopods, 2-segmented endopods. Total length 7.17 mm. Holotype: USNM 113535.

Remarks: *P. lacertosus* differs from *P. ovalis* Sars, a species it resembles, in the presence of a rostrum and additional setae on the second basal segment, endopod and exopod of the first maxilla.

***Phyllopus muticus* Sars, 1907**

FIGURES 266–270

Remarks: A very large female (total length 7.21 mm) was found at one station. Figures of this specimen including illustrations of some appendages not heretofore figured are given here.

***Bathypontia elongata* Sars, 1905**

FIGURES 271–274

Remarks: Several figures of the male are given here. The rostrum of the male is rounded and unlike that found in the female. Total length 4.68 mm. *Bathypontia elongata* has not previously been reported from the Indian Ocean.

***Bathypontia regalis*, new species**

FIGURES 275–280

Occurrence: Station 338 NV, 3000 to 2000 m, 1 ♂.

Diagnosis (male): Head and first thoracic segment separate, fourth and fifth thoracic segments separate. Posterior lateral corner of fifth thoracic segment broadly rounded. Rostrum robust and rounded. Exopods of first through fourth feet 3-segmented, endopods of first foot 2-segmented, of second through fourth feet 3-segmented.

Left fifth foot 5-segmented with hair on internal margin of second and third segments. Right fifth foot 5-segmented. Total length 2.32 mm. Holotype: USNM 113537.

Remarks: This species resembles the male of *B. major* (Wolfenden) but the small size of the present specimen and the inflated and pubescent second segment of the left fifth foot will distinguish it from *B. major*.

Rhinomaxillaris, new genus

Type-species: *Rhinomaxillaris bathybia*, new species.

Rhinomaxillaris bathybia, new species

FIGURES 281–292

Occurrence: Station 330 NV, 2000 to 1000 m, 1 ♀.

Diagnosis (female): Head and first thoracic segment incompletely separate, fourth and fifth thoracic segments incompletely separate. Abdomen 4-segmented. Anal segment longer than preceding segment and furca. Rostrum large and obtuse. First antenna reaching to fifth thoracic segment. Segments 8 and 9, 24 and 25 fused. Exopod of second antenna consisting of seven segments, about twice the length of the endopod. Mandible palpus with two setae. First maxilla with two setae on second inner lobe, five setae on endopod and two setae on exopod. Second maxilla with 5 lobes bearing 1, 1, 3, 3, and 2 setae, respectively. Maxilliped large, with long and coarse setae distally. First foot with 3-segmented exopod and 1-segmented endopod. First and second exopodal segments of first foot without external spines. Exopods of second through fourth feet broken off. Endopods of second foot 2- or 3-segmented, of third and fourth feet 3-segmented. Third endopodal segments of third and fourth feet with six setae. Total length 1.12 mm. Holotype: USNM 113538.

REMARKS.—We found one female specimen of a calanoid copepod for which we establish a new genus and species. It was difficult to assign this species to an existing family. Characteristics of this specimen can be found in the genera of the family Bathypontiidae Brodsky: *Bathypontia* Sars, *Temorites* Sars, *Zenkevitchiella* Brodsky, and *Foxtonia* Hulsemann and Grice . The last two of these genera were tentatively placed in this family.

The large, blunt rostrum of *Rhinomaxillaris* is similar to that found in *Bathypontia*. There are 23 free segments in the first antenna of all four genera mentioned except in the species *Temorites discoveryae* Grice and Hulsemann. Segments 24 and 25 are fused in all species in the family. In general, the second maxilla and the maxilliped resemble those in the other genera in the family with respect to their compact form and the strong, spinelike setae on the endopods. The

first and second exopodal segments of the first foot lack external spines as is the case in *Bathypontia*, *Temorites*, and *Foxtonia*. The absence of fifth feet is common to the female of *Foxtonia*.

The new genus *Rhinomaxillaris* is distinguished from *Bathypontia* and *Temorites* by the long exopod in the second antenna, the shape and arrangement of the teeth on the mandible blade, and the absence of fifth feet. *Rhinomaxillaris* differs from *Zenkevitchiella* and *Foxtonia* in the long exopod of the second antenna, the mandible blade, and the peculiar rostrum. From *Zenkevitchiella*, *Rhinomaxillaris* is further distinguished by the absence of external spines on the first and second exopodal segments of the first foot, and the absence of fifth feet. It differs from *Foxtonia* in the increased number of segments in the endopods of the second and third feet and in the absence of spinelike setae between the bases of the first antenna. *Rhinomaxillaris* also resembles certain genera in the family *Pseudocalanidae*. The large and blunt rostrum, the fused 24th and 25th segments in the first antenna, and the absence of external spines on the first and second exopodal segments of the first foot prevent *Rhinomaxillaris* from being placed in this family.

Until a female with intact swimming feet and a male are found, it is not possible to establish the true familial relationship of *Rhinomaxillaris*. In the meantime we have tentatively placed it in the family Bathypontiidae with the full realization that until this family is critically studied it may represent a composite of unrelated genera.

Until additional species are discovered, the genus *Rhinomaxillaris* cannot be diagnosed.

***Zenkevitchiella atlantica* Grice and Hulsemann, 1965**

Remarks: In the single specimen found segments seven and eight of the first antenna are fused as is shown in figure 22(a) in our description of this species from North Atlantic specimens (Grice and Hulsemann, 1965) and not segments eight and nine as stated in the text. Segments 24 and 25 are fused and not segments 23 and 24 as also stated in the text. The distal end of the first antennae are broken off in the Indian Ocean specimen. It may be added here that in the male of *Zenkevitchiella atlantica* described by us (1965), segments seven and eight of the first antenna are fused. No male of this species has yet been found in the Indian Ocean. The occurrence of a female of *Zenkevitchiella atlantica* represents a new record for the Indian Ocean.

***Zenkevitchiella crassa*, new species**

FIGURES 293–305

Occurrence: Station 340 NV, 2950 to 1990 m, 1 ♂.

Diagnosis (male): Head and first thoracic segment incompletely

separate, fourth and fifth thoracic segments separate. Posterior lateral corner of fifth thoracic segment rounded. Rostrum 2-pointed, each point with a filament. Right first antenna geniculate, fifth segment from end with two rounded knobs. Endopod of second antenna about two-thirds the length of exopod. Mandible with two setae on palpus. First maxilla with one seta on second inner lobe, two setae on third inner lobe, one seta on second basal segment, endopod absent, exopod with five setae. Second maxilla with five well-defined lobes bearing 3, 2, 1, 3, 2 setae, respectively. Long and coarse setae on distal lobe and on end of appendage. Maxilliped with coarse setae distally. Exopods of first through fourth feet 3-segmented. Endopods of first foot 1-segmented, of second through fourth feet 3-segmented. Second basal segment of third foot with distolateral spinelike protrusion. Fifth feet with right exopod 2-segmented, left exopod 1-segmented. Right endopod a small knob, left endopod large and bearing a large spine distally. Total length .84 mm. Holotype: USNM 113539.

Remarks: This species is different from *Z. atlantica* Grice and Hulsemann in the structure of the endopods of the fifth feet. In *Z. atlantica* the endopods are bulbous, and neither bears a spine. The male of *Z. abyssalis* Brodsky is not known. It is unlikely that the present specimen is the male of *Z. abyssalis* as this is a relatively large species (2.37 mm).

Unidentified Male

FIGURES 306–319

Diagnosis (male): Head and first thoracic segment separate, fourth and fifth thoracic segments fused. Abdomen 5-segmented, anal segment longer than preceding, equal in length to furca. Rostrum robust, broadly rounded at tip. Left first antenna geniculate, numerous aesthetasks on proximal segments. Endopod of second antenna about two-thirds the length of exopod. Endopod of mandible about two-thirds the length of exopod. Palpus devoid of setae. Blade with one large and two small teeth, distal end covered with numerous small spines. First maxilla with one seta on second inner lobe, three setae on third inner lobe, two setae on second basal segment, nine setae on endopod, and seven setae on exopod. Second maxilla with five lobes bearing 4, 3, 3, 3, and 1 setae, respectively. Maxillipeds broken off distally. Swimming feet broken off. Fifth feet uniramous, each ramus 5-segmented. Distal segment of left foot with 2 spinelike protrusions terminally. Total length .72 mm.

Remarks: In most respects the present male is similar to the males of the two *Disco* species (family Augaptilidae) described earlier. However, the uniramous fifth feet of the present male apparently preclude

its referral to the genus *Disco* and the family Augaptilidae. Until females are discovered, we will not attempt a family designation or generic description.

Summary

Calanoid copepods were identified in 51 samples collected by Bé multiple sampler, Isaacs-Kidd midwater trawl, and modified Nansen vertical net at stations located in the western Indian Ocean between the northern Arabian Sea and approximately the subtropical convergence. The Bé net collections were obtained between 2000 and 1000 m, the midwater trawl samples between the surface and a maximum depth of 3820 m, and the Nansen vertical net samples between 2000 and 1000, 3000 and 2000, and 4000 and 3000 m.

The displacement volumes of the zooplankton and numerical density and size of the copepods collected by the Nansen net were determined and compared to similar collections made in the northeastern Atlantic. In general, the total zooplankton as well as the copepods were more abundant in the 2000–1000 m depth interval than in intervals below 2000 m. The mean size of the animals was larger in the 2000–1000 m interval than in the 3000–2000 m interval. The values obtained for the displacement volumes, numerical abundance, and mean size were similar to those in comparable depth intervals in the northeastern Atlantic.

The greatest number of species in the Nansen vertical collections were found between 2000 and 1000 m (122), a lesser number between 3000 and 2000 m (73), and the least number between 4000 and 3000 m (13). This decrease in diversity with increasing depth is similar to that found in the northeastern Atlantic.

The distribution of 269 species found in the western Indian Ocean was discussed and compared to previous discussions of the geographic distribution of Indian Ocean bathypelagic copepods and to water mass distribution. The very widespread distribution of the bathypelagic species was indicated by the great similarity in species composition between the North Atlantic and western Indian Oceans. Eighty-six percent of the western Indian Ocean species are also present in the North Atlantic. Five typically Antarctic species were found in four samples collected in the southern Indian Ocean near the subtropical convergence.

Included in the 310 species found are 1 new genus, 17 new species, 8 previously unknown males, and 1 previously unknown female. Seventy-eight of the 310 species excluding the newly described ones have not been previously reported from the Indian Ocean. Seven species are apparently known only from the Indian Ocean.

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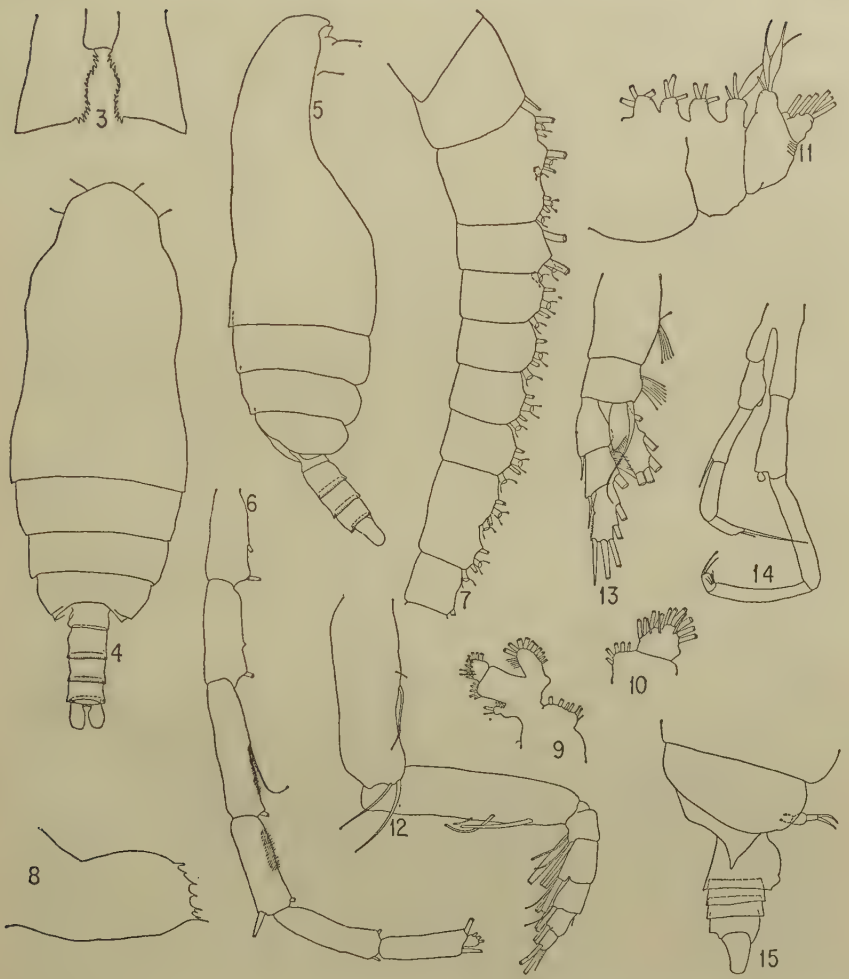
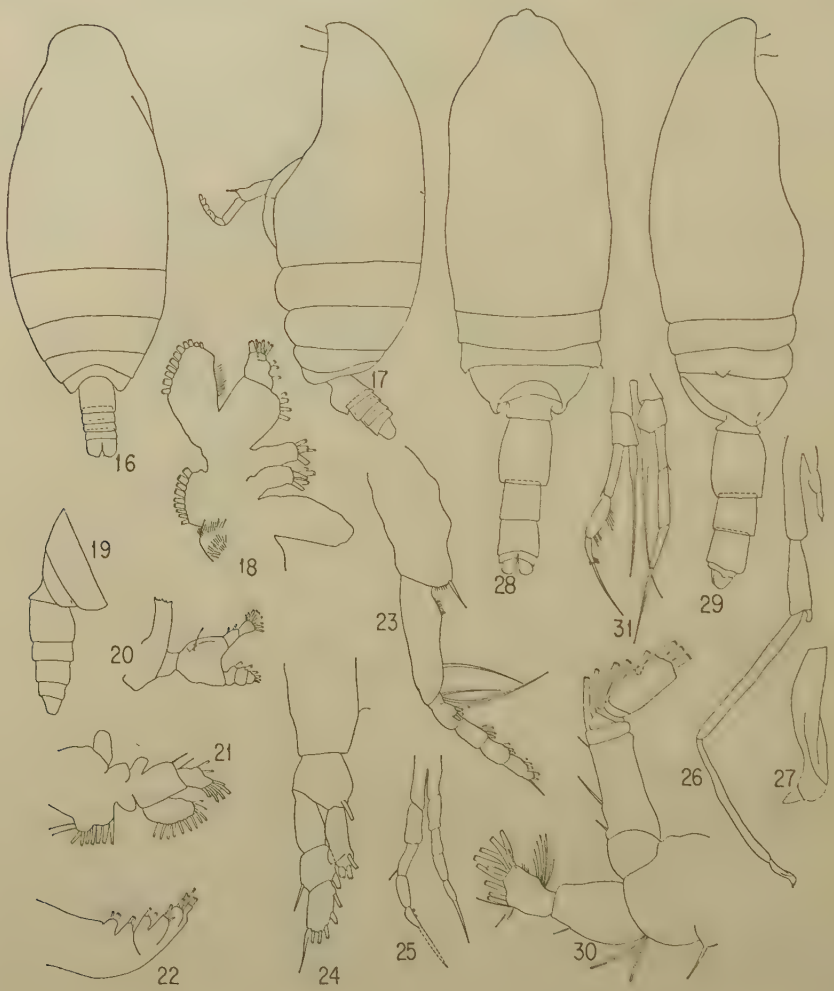
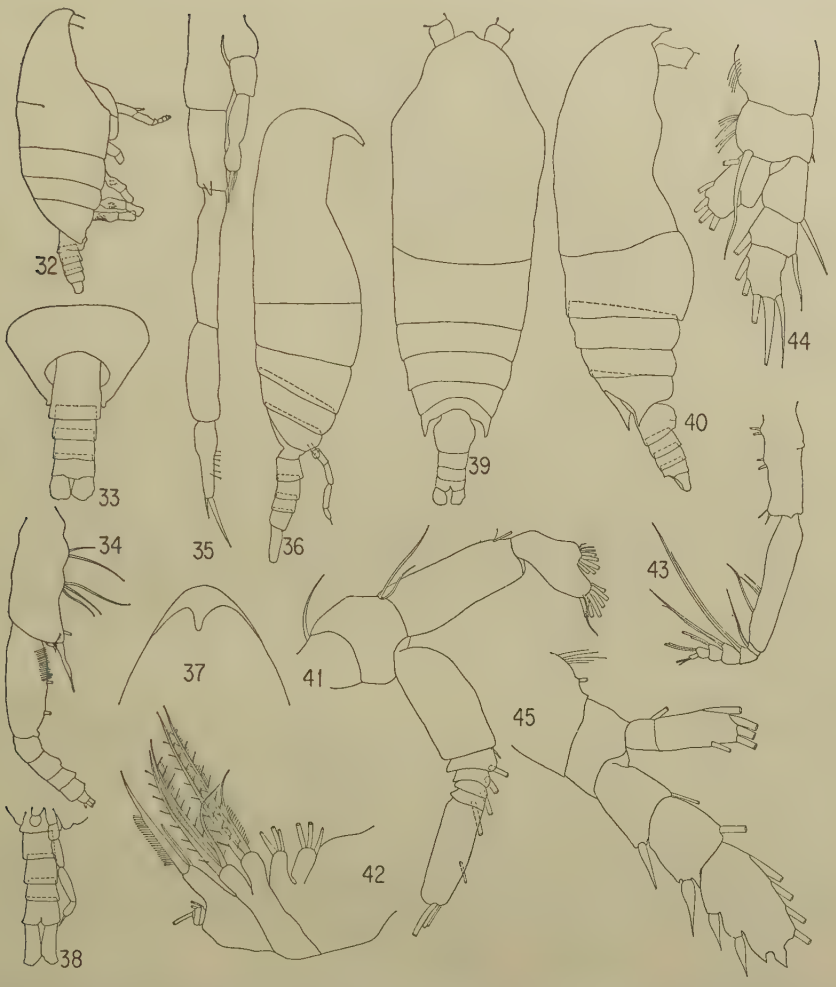


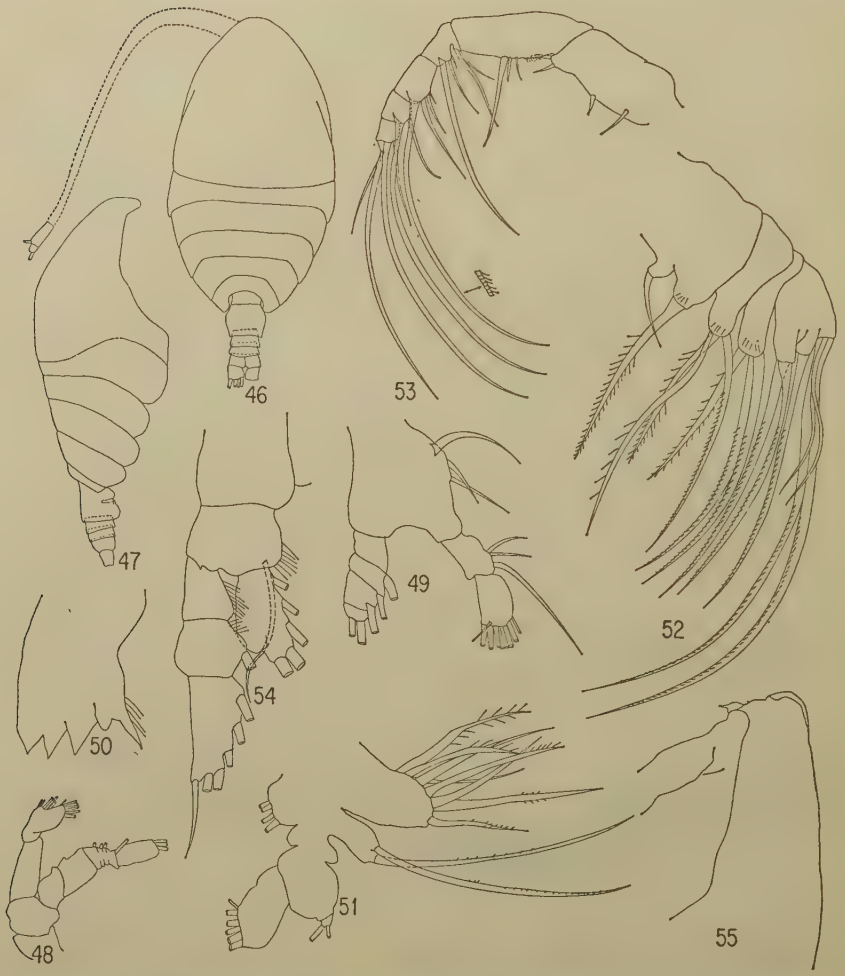
FIGURES 3–15.—*Calanus australis*, female: 3, first basipodal segments of fifth feet. *Farrania frigida*, male: 4, dorsal view; 5, lateral view; 6, distal end of right first antenna; 7, proximal end of right first antenna; 8, mandible blade; 9, first maxilla (first inner lobe omitted); 10, second basal segment and endopod of first maxilla; 11, second maxilla; 12, maxilliped; 13, first foot; 14, fifth foot; 15, female, posterior end of thorax and abdomen.



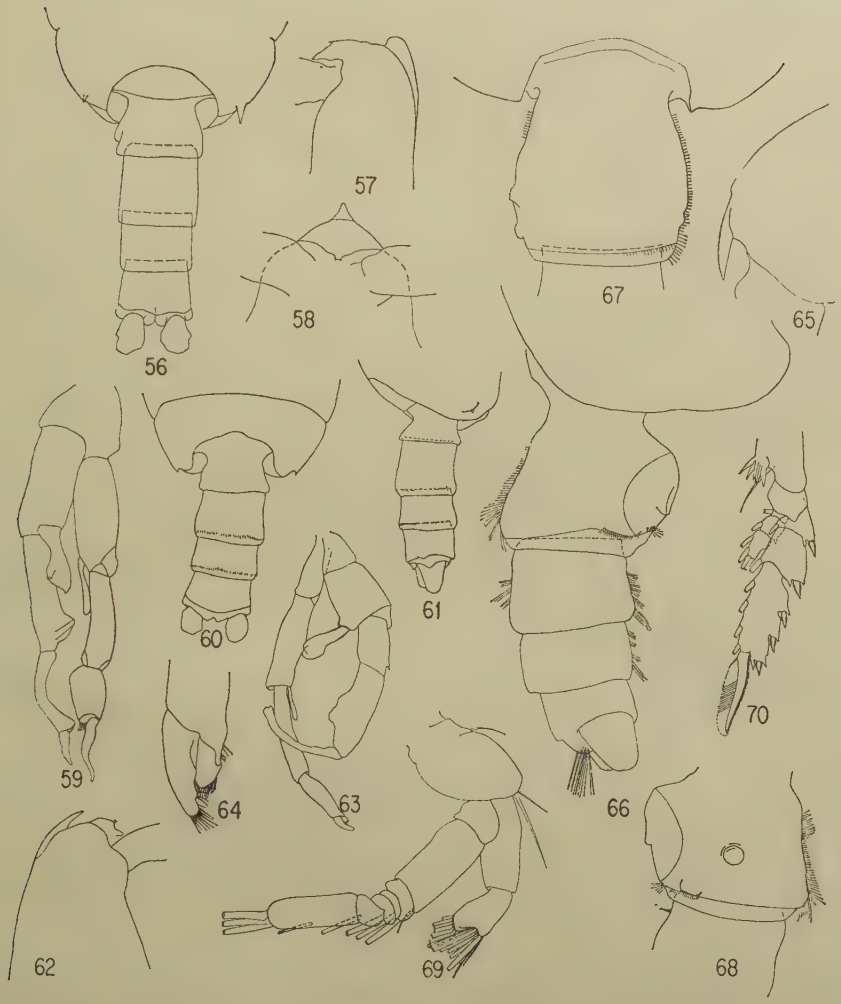
FIGURES 16–31.—*Mimocalanus inflatus?*, female: 16, dorsal view; 17, lateral view; 18, first maxilla (spines on inner lobe omitted). *Mimocalanus* species, male: 19, posterior end of thorax and abdomen, lateral view; 20, mandible; 21, first maxilla; 22, second maxilla; 23, maxilliped; 24, first foot; 25, fifth feet. *Spinocalanus longipes*, male: 26, fifth feet; 27, terminal segment of left fifth foot. *Spinocalanus validus*, male: 28, dorsal view; 29, lateral view; 30, second antenna; 31, fifth feet.



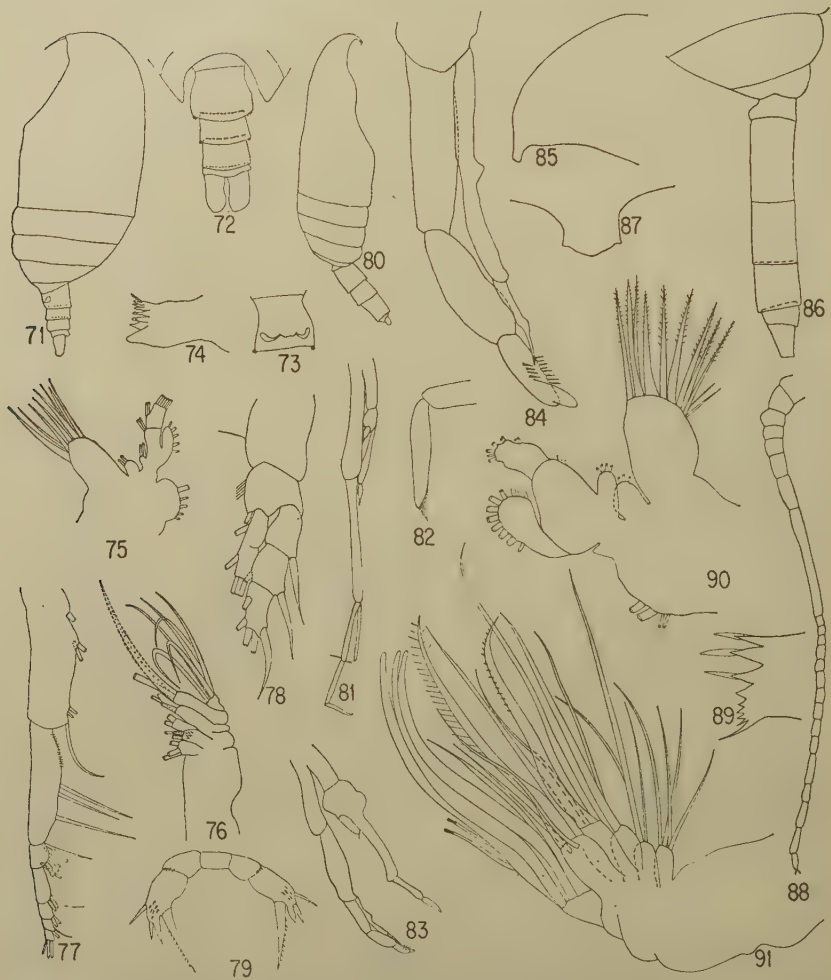
FIGURES 32–45.—*Spinocalanus ventriosus*, new species, female: 32, lateral view; 33, fifth thoracic segment and abdomen, dorsal view; 34, maxilliped (setae on distal segments omitted). *Spinocalanus* species, male: 35, fifth feet. *Teneriforma naso*, male: 36, lateral view; 37, anterior end of head, ventral view; 38, fifth feet and abdomen, ventral view. *Aetideopsis retusa*, new species, female: 39, dorsal view; 40, lateral view; 41, second antenna; 42, second maxilla; 43, maxilliped; 44, first foot; 45, second foot (terminal spine on exopod broken off).



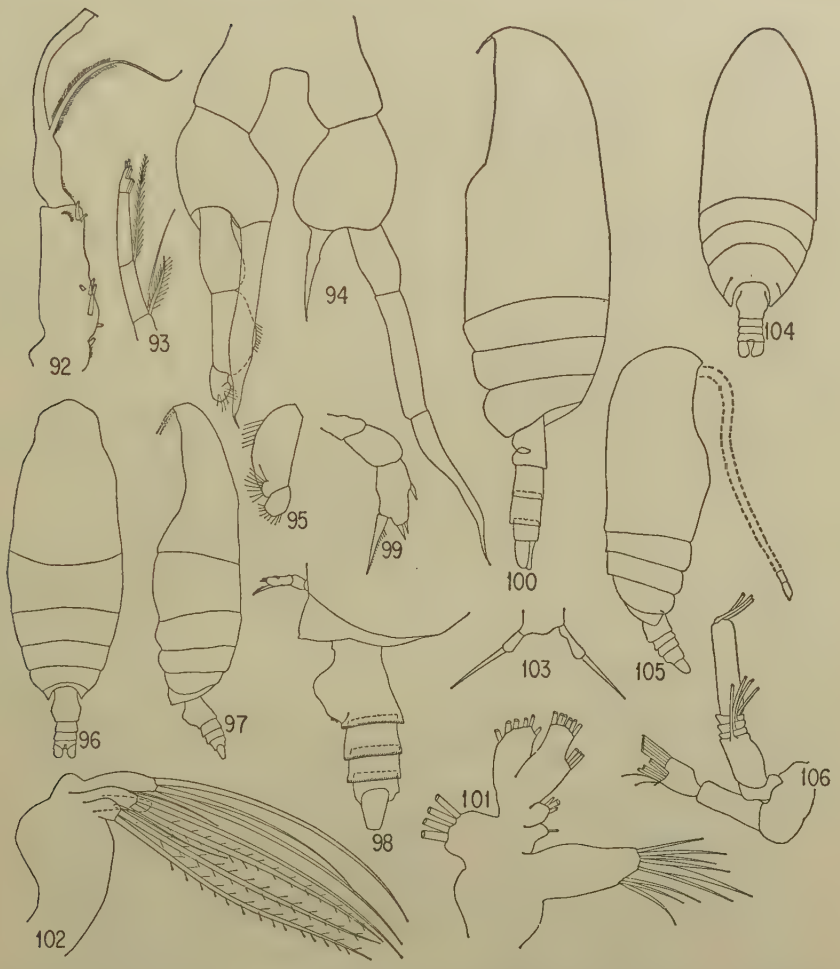
FIGURES 46–55.—*Bradyetes florens*, new species, female: 46, dorsal view; 47, lateral view; 48, second antenna; 49, mandible palpus; 50, mandible blade; 51, first maxilla; 52, second maxilla; 53, maxilliped; 54, first foot. *Chirundinella cara*, female: 55, head, lateral view.



FIGURES 56–70.—*Gaetanus ferox*, male: 56, fifth thoracic segment and abdomen, dorsal view; 57, anterior end of head, lateral view; 58, anterior end of head, ventral view; 59, fifth feet. *Gaidius robustus*, male: 60, fifth thoracic segment and abdomen, dorsal view; 61, fifth thoracic segment and abdomen, lateral view; 62, anterior end of head, lateral view; 63, fifth feet; 64, distal end of left fifth foot. *Pseudochirella squalida*, new species, female: 65, anterior end of head, lateral view; 66, abdomen, lateral view; 67, genital segment, dorsal view; 68, genital segment, left side; 69, second antenna; 70, fourth foot.



FIGURES 71–91.—*Xanthocalanus hispidus*, new species, female: 71, lateral view; 72, fifth thoracic segment and abdomen, dorsal view; 73, genital segment, ventral view; 74, mandible blade; 75, first maxilla; 76, second maxilla; 77, maxilliped; 78, first foot; 79, fifth feet. *Amallothrix indica*, male: 80, lateral view; 81, fifth feet; 82, distal end of left fifth foot. *Amallothrix paravalida*, male: 83, fifth feet; 84, left fifth foot. *?Racovitzanus* species, male: 85, anterior end of head, lateral view; 86, posterior end of thorax and abdomen, lateral view; 87, rostrum, ventral view; 88, right first antenna; 89, mandible blade; 90, first maxilla; 91, second maxilla.



FIGURES 92–106.—*?Racovitzanus* species, male: 92, basipodal segments of maxilliped; 93, distal segments of maxilliped (enlarged); 94, fifth feet; 95, distal segments of left fifth foot. *Scaphocalanus bogorovi*, female: 96, dorsal view; 97, lateral view; 98, fifth thoracic segment and abdomen, lateral view; 99, fifth foot. *Scolecithricella grata*, new species, female: 100, lateral view; 101, first maxilla; 102, second maxilla; 103, fifth feet. *Scolecithricella maritima*, new species, female: 104, dorsal view; 105, lateral view; 106, second antenna.

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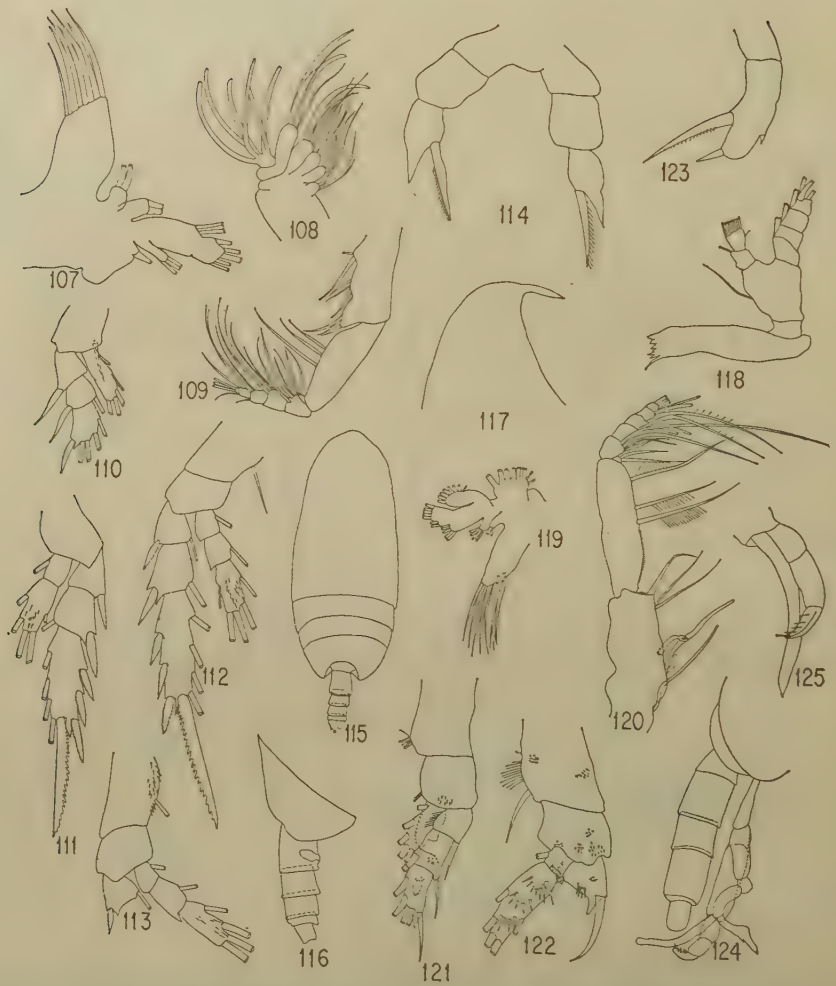
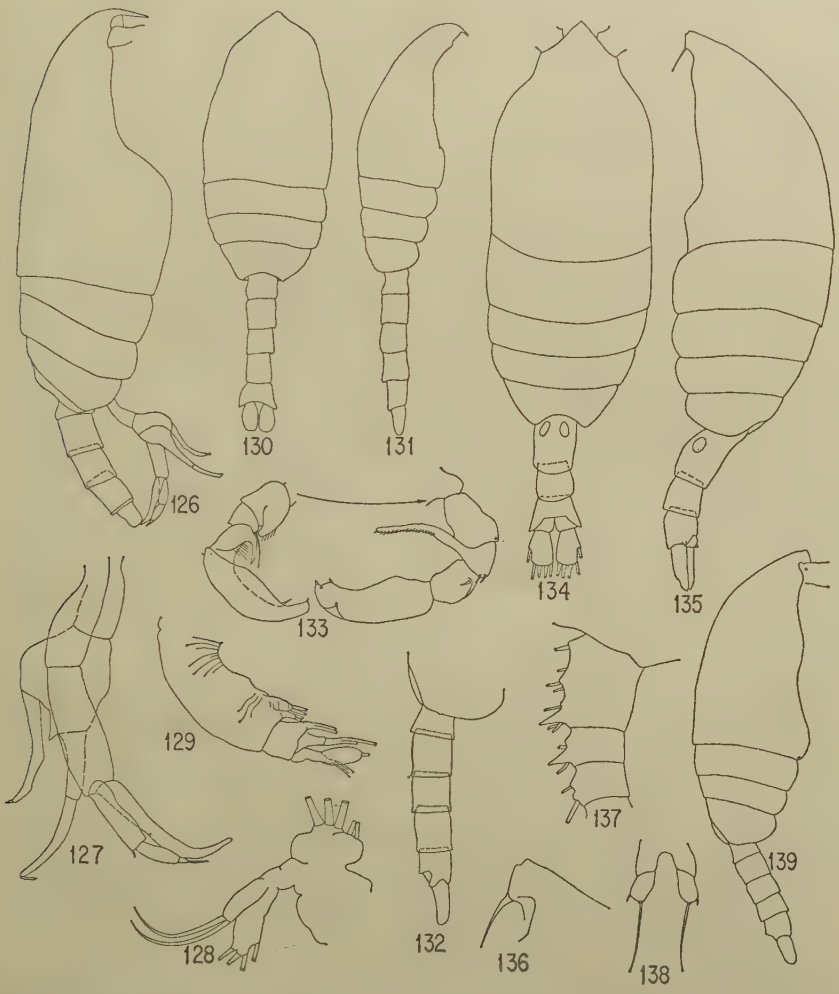
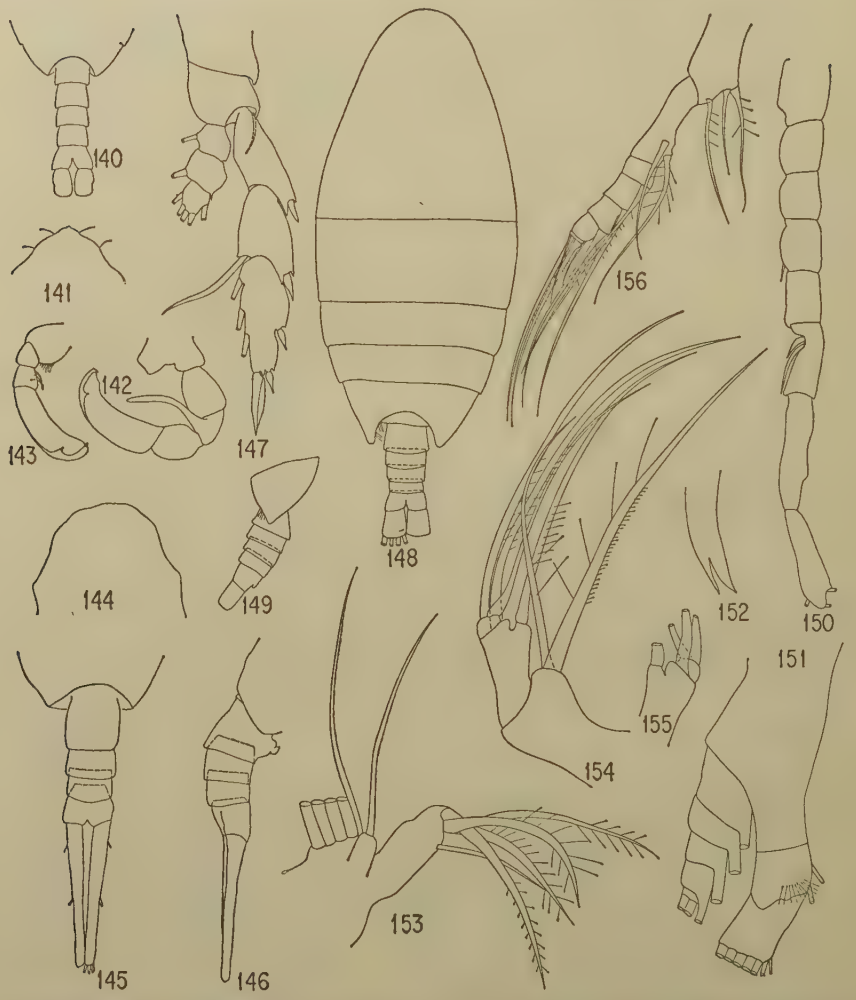


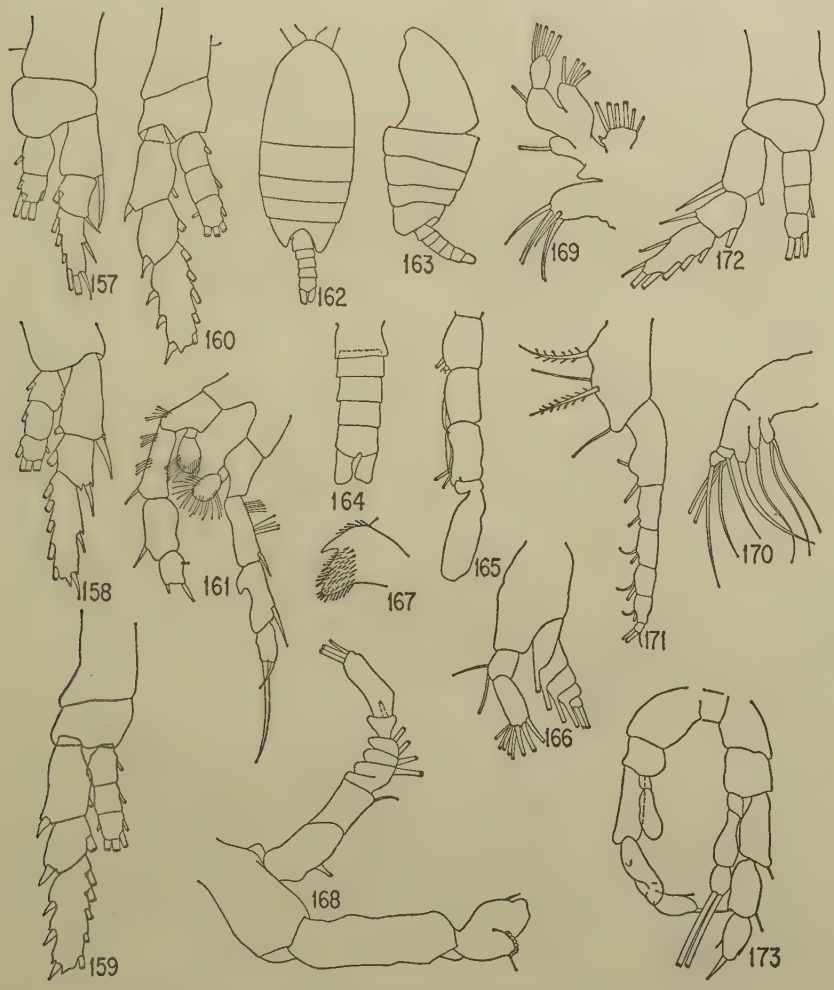
FIGURES 107–125.—*Scolecithricella maritima*, new species, female: 107, first maxilla; 108, second maxilla; 109, maxilliped; 110, first foot; 111, second foot; 112, third foot; 113, fourth feet (second and third exopodal segments broken off); 114, fifth feet. *Scolecithricella timida*, female: 115, dorsal view; 116, fourth and fifth thoracic segments and abdomen, lateral view; 117, anterior end of head, lateral view; 118, mandible; 119, first maxilla; 120, maxilliped; 121, first foot; 122, second foot (second and third exopodal segments broken off); 123, fifth foot. *Scolecithricella*, species, male: 124, abdomen and fifth feet, lateral view; 125, distal end of left fifth foot (enlarged).



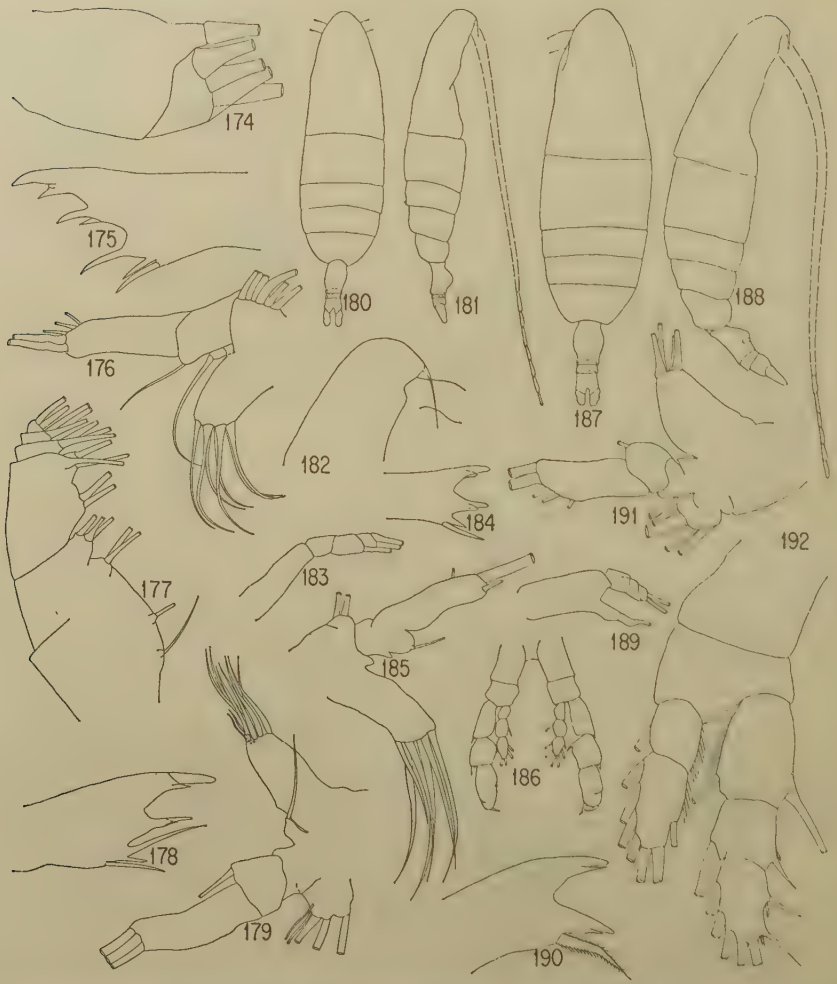
FIGURES 126–139.—*Scolecithrix fowleri*, male: 126, lateral view; 127, fifth feet; 128, first maxilla; 129, second maxilla. *Metridia boecki?*, male: 130, dorsal view; 131, lateral view; 132, fifth thoracic segment and abdomen, lateral view; 133, fifth feet. *Metridia effusa*, new species, female: 134, dorsal view; 135, lateral view; 136, anterior end of head, lateral view; 137, proximal end of first antenna; 138, fifth feet; 139, male, lateral view.



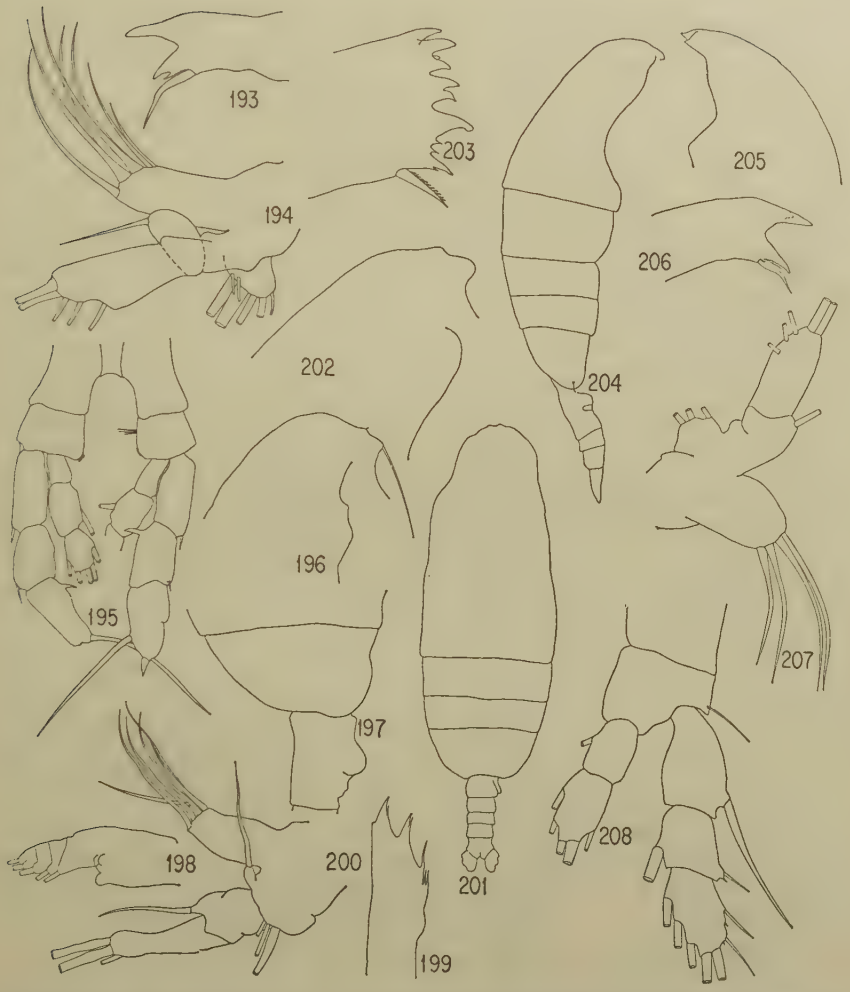
FIGURES 140–156.—*Metridia effusa*, new species, male: 140, fourth and fifth thoracic segments and abdomen, dorsal view; 141, anterior end of head, dorsal view; 142, right fifth foot; 143, left fifth foot. *Lucicutia major*, female: 144, anterior end of head, dorsal view; 145, fifth thoracic segment and abdomen, dorsal view; 146, fifth thoracic segment and abdomen, lateral view; 147, fifth foot. *Disco inflatus*, male: 148, dorsal view; 149, fifth thoracic segment and abdomen, lateral view; 150, distal segments of left first antenna; 151, mandible palpus; 152, mandible blade; 153, first maxilla; 154, second maxilla; 155, distal end of second maxilla, other side; 156, maxilliped.



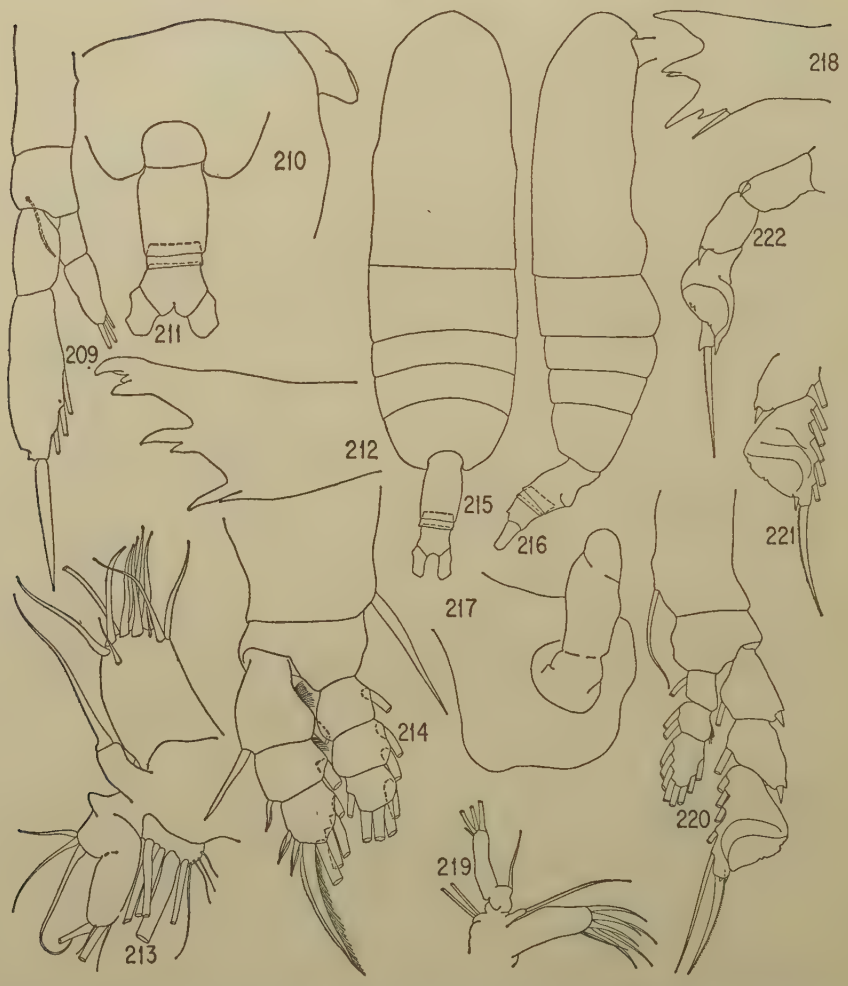
FIGURES 157–173.—*Disco inflatus*, male: 157, first foot; 158, second foot (terminal spine broken off); 159, third foot (terminal spine broken off); 160, fourth foot (terminal spine broken off); 161, fifth feet. *Disco* species, male: 162, dorsal view; 163, lateral view; 164, abdomen dorsal view; 165, segments 15–18 of left first antenna; 166, mandible palpus; 167, mandible blade; 168, second antenna (distal setae of endopod broken off); 169, first maxilla; 170, second maxilla; 171, maxilliped; 172, first foot; 173, fifth feet.



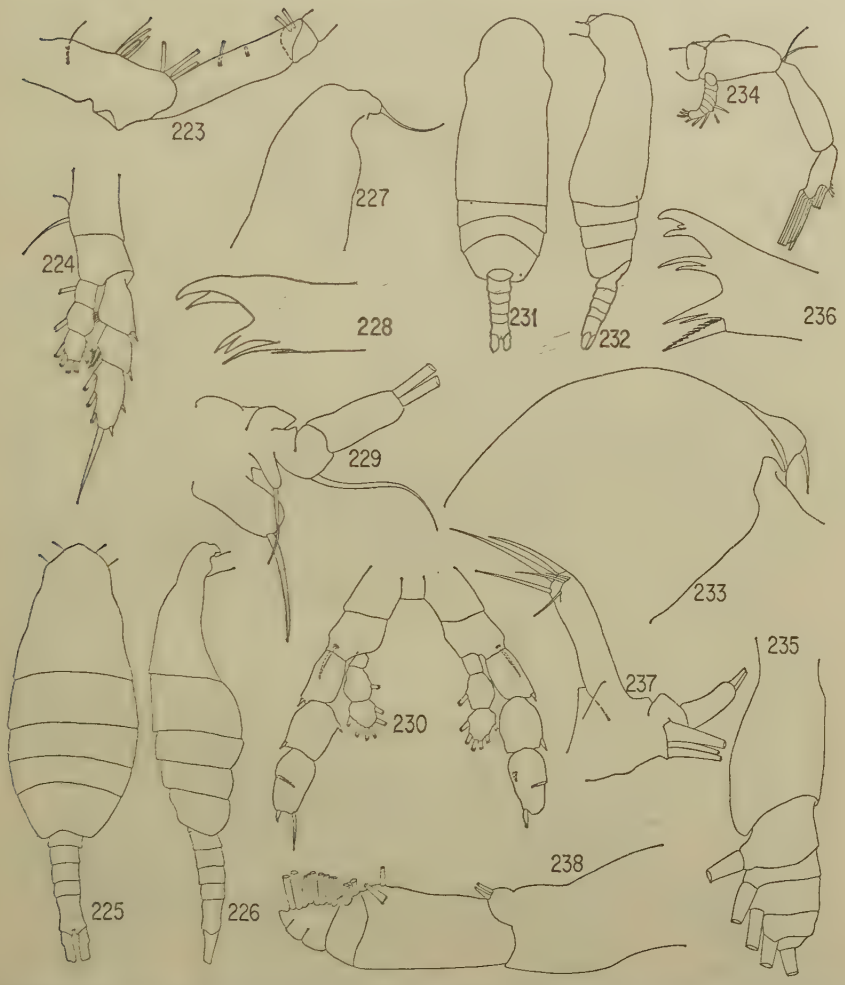
FIGURES 174–192.—*Euaugaptilus brodskyi*, female: 174, mandible palpus; 175, mandible blade; 176, first maxilla; 177, second maxilla; 178, male, mandible blade; 179, first maxilla. *Euaugaptilus curtus*, new species, female: 180, dorsal view; 181, lateral view; 182, anterior portion of head, lateral view; 183, mandible palpus; 184, mandible blade; 185, first maxilla; 186, male, fifth feet. *Euaugaptilus fundatus*, new species, female: 187, dorsal view; 188, lateral view; 189, mandible palpus; 190, mandible blade; 191, first maxilla; 192, first foot.



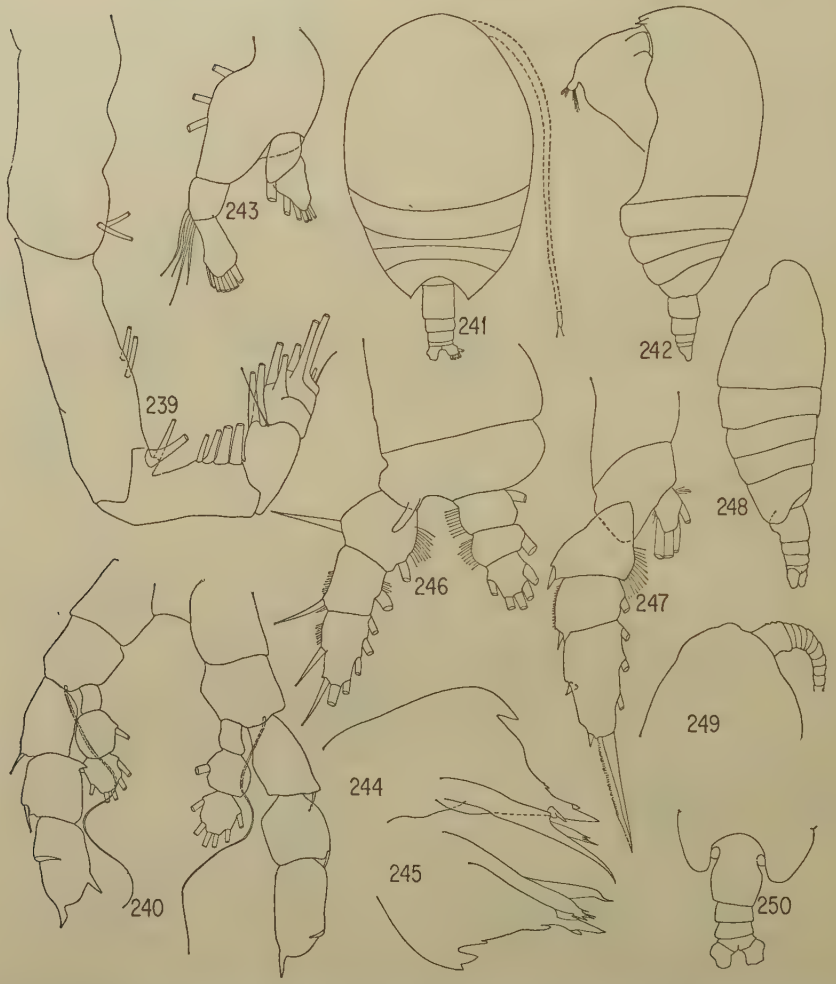
FIGURES 193–208.—*Euaugaptilus longiseta*, male: 193, mandible blade; 194, first maxilla; 195, fifth feet (terminal segment of right endopod incomplete). *Euaugaptilus malacus*, new species, female: 196, anterior portion of head, lateral view; 197, fifth thoracic segment and genital segment; 198, mandible palpus; 199, mandible blade; 200, first maxilla. *Euaugaptilus nodifrons*, male: 201, dorsal view; 202, anterior portion of head, lateral view; 203, mandible blade. *Euaugaptilus quaesitus*, new species, female: 204, lateral view; 205, anterior portion of head, lateral view; 206, mandible blade; 207, first maxilla; 208 first foot.



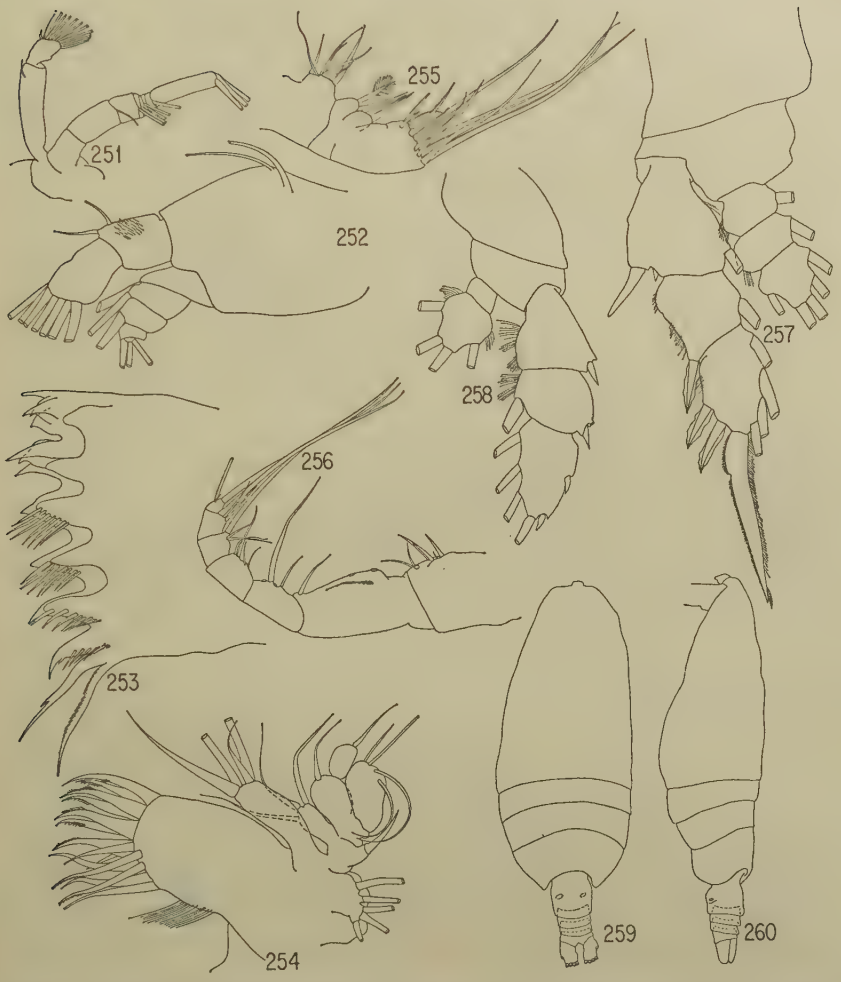
FIGURES 209–222.—*Euaugaptilus quaesitus*, new species, female: 209, fifth foot. *Euaugaptilus rectus*, new species, female: 210, anterior portion of head, lateral view; 211, abdomen, dorsal view; 212, mandible blade; 213, first maxilla; 214, first foot. *Euaugaptilus* species 1, female: 215, dorsal view; 216, lateral view; 217, mandible palpus with basis of mandible blade; 218, mandible blade; 219, first maxilla; 220, third foot, anterior side; 221, second and third exopodal segments of third foot, posterior side; 222, exopod of left third foot, external side.



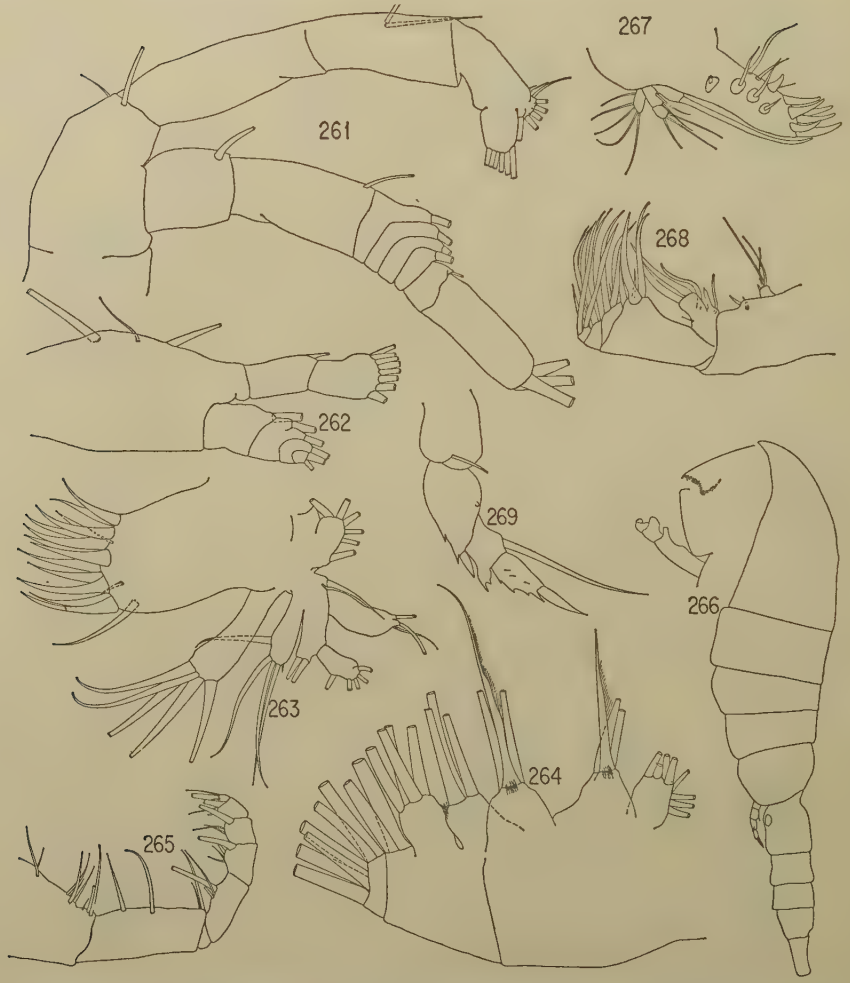
FIGURES 223–238.—*Euaugaptilus* species 1, female: 223, basipodal segments of maxilliped; 224, fifth foot. *Euaugaptilus* species 2, male: 225, dorsal view; 226, lateral view; 227, anterior portion of head, lateral view; 228, mandible blade; 229, first maxilla; 230, fifth feet. *Euaugaptilus* species 3, male: 231, dorsal view; 232, lateral view; 233, anterior portion of head, lateral view; 234, second antenna; 235, mandible palpus; 236, mandible blade; 237, first maxilla; 238, second maxilla.



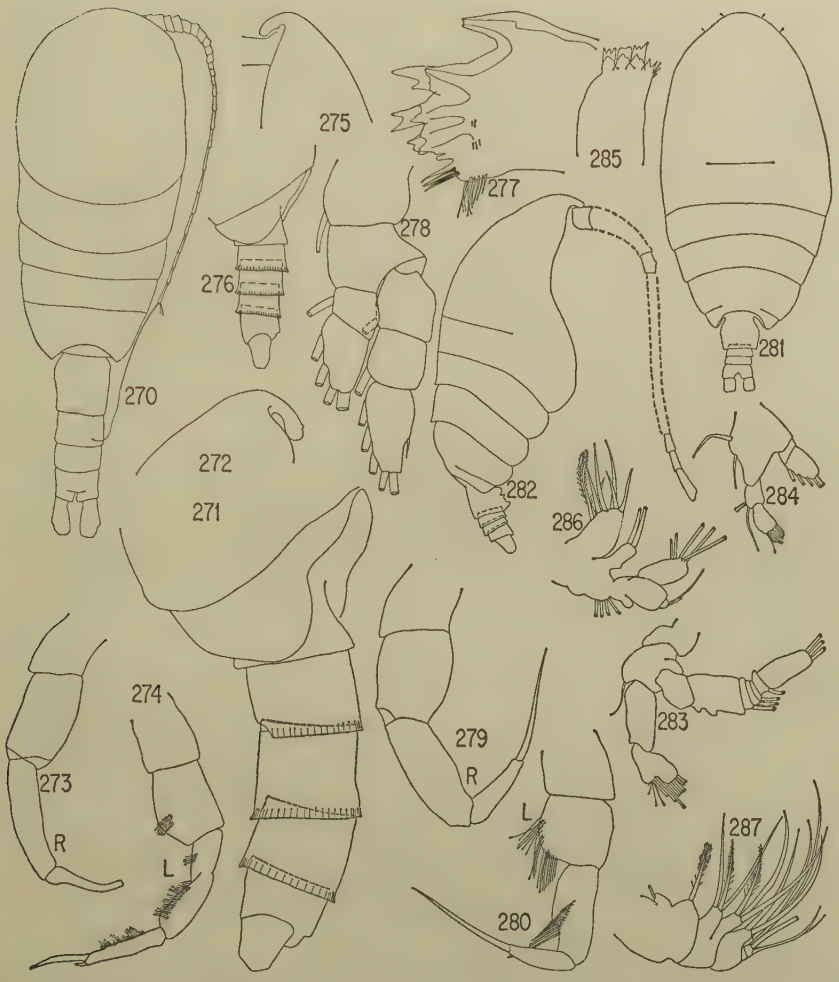
FIGURES 239–250.—*Euaugaptilus* species 3, male: 239, maxilliped; 240, fifth feet. *Pachyptilus abbreviatus*, female: 241 dorsal view; 242, lateral view; 243, mandible palpus; 244, mandible blade; 245, mandible blade, another view; 246, first foot; 247, fifth foot. *Pontoptilus robustus*, female: 248, lateral view; 249, anterior portion of head, dorsal view; 250, fifth thoracic segment and abdomen, dorsal view.



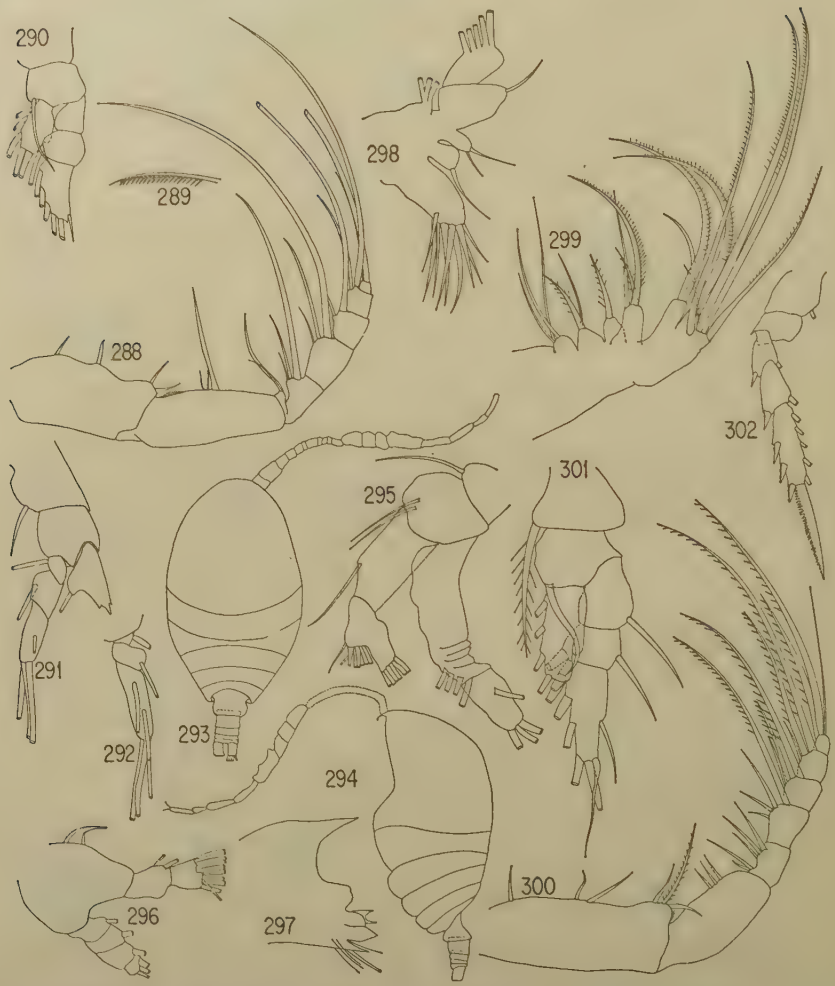
FIGURES 251–260.—*Pontoptilus robustus*, female: 251, second antenna; 252, mandible palpus; 253, mandible blade; 254, first maxilla; 255, second maxilla; 256, maxilliped; 257, first foot; 258, fifth foot. *Pontoptilus lacertosus*, new species, female: 259, dorsal view; 260, lateral view.



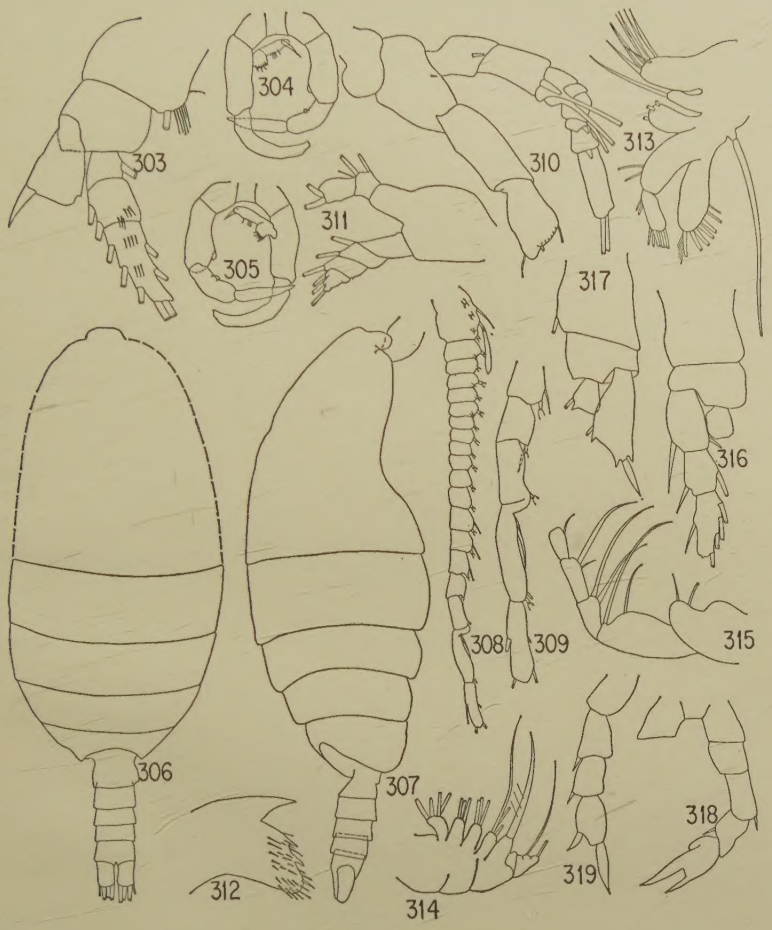
FIGURES 261–269.—*Pontoptilus lacertosus*, new species, female: 261, second antenna; 262, mandible palpus; 263, first maxilla; 264, second maxilla; 265, maxilliped. *Phyllopus muticus*, female: 266, lateral view; 267, first maxilla; 268, second maxilla; 269, fifth foot.



FIGURES 270–287.—*Phyllopus muticus*, female: 270, dorsal view. *Bathypontia elongata*, male: 271, fifth thoracic segment and abdomen, lateral view; 272, anterior portion of head, lateral view; 273, right fifth foot; 274, left fifth foot. *Bathypontia regalis*, new species, male: 275, anterior portion of head, lateral view; 276, fifth thoracic segment and abdomen, lateral view; 277, mandible blade; 278, first foot; 279, right fifth foot; 280, left fifth foot. *Rhinomaxillaris bathybia*, new genus and new species, female: 281, dorsal view; 282, lateral view; 283, second antenna; 284, mandible palpus; 285, mandible blade; 286, first maxilla; 287, second maxilla.



FIGURES 288–302.—*Rhinomaxillaris bathybia*, new genus and new species, female: 288, maxilliped; 289, distal portion of strong spine on maxilliped, enlarged; 290, first foot; 291, fourth foot (exopod incomplete); 292, endopod of fourth foot, another view. *Zenkevitchiella crassa*, new species, male: 293, dorsal view; 294, lateral view; 295, second antenna; 296, mandible palpus; 297, mandible blade; 298, first maxilla; 299, second maxilla; 300, maxilliped; 301, first foot; 302, third foot (endopod omitted).



FIGURES 303–319.—*Zenkevitchiella crassa*, new species, male: 303, second foot (exopod incomplete); 304, fifth feet, posterior side; 305, fifth feet; anterior side. Unidentified male: 306, dorsal view; 307, lateral view; 308, left first antenna; 309, distal segments of left first antenna (enlarged); 310, second antenna; 311, mandible palpus; 312, mandible blade; 313, first maxilla; 314, second maxilla; 315, maxilliped; 316, first foot (endopod incomplete); 317, third foot (exopod and endopod incomplete); 318, left fifth foot with first segment of right fifth foot; 319, right fifth foot without first segment.

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